

IFC Model Servers

26 Feb, 2004

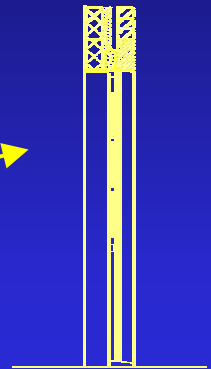
Francois Grobler,
with material from Jim Mitchell
and Patrick Houbaux

Presentation Overview

- IFC basics
 - ◆ IFC is ready!
- Why Building Information Model (BIM)?
 - ◆ O&M FAN should be BIM-based
- Project use of IFC Model Server
 - ◆ IFC can be used for real projects
- IFC model servers - introduction
 - ◆ IFC model servers available for prototype FAN
- The SABLE project
 - ◆ Recommend FAN participation in SABLE FM work
- Conclusions

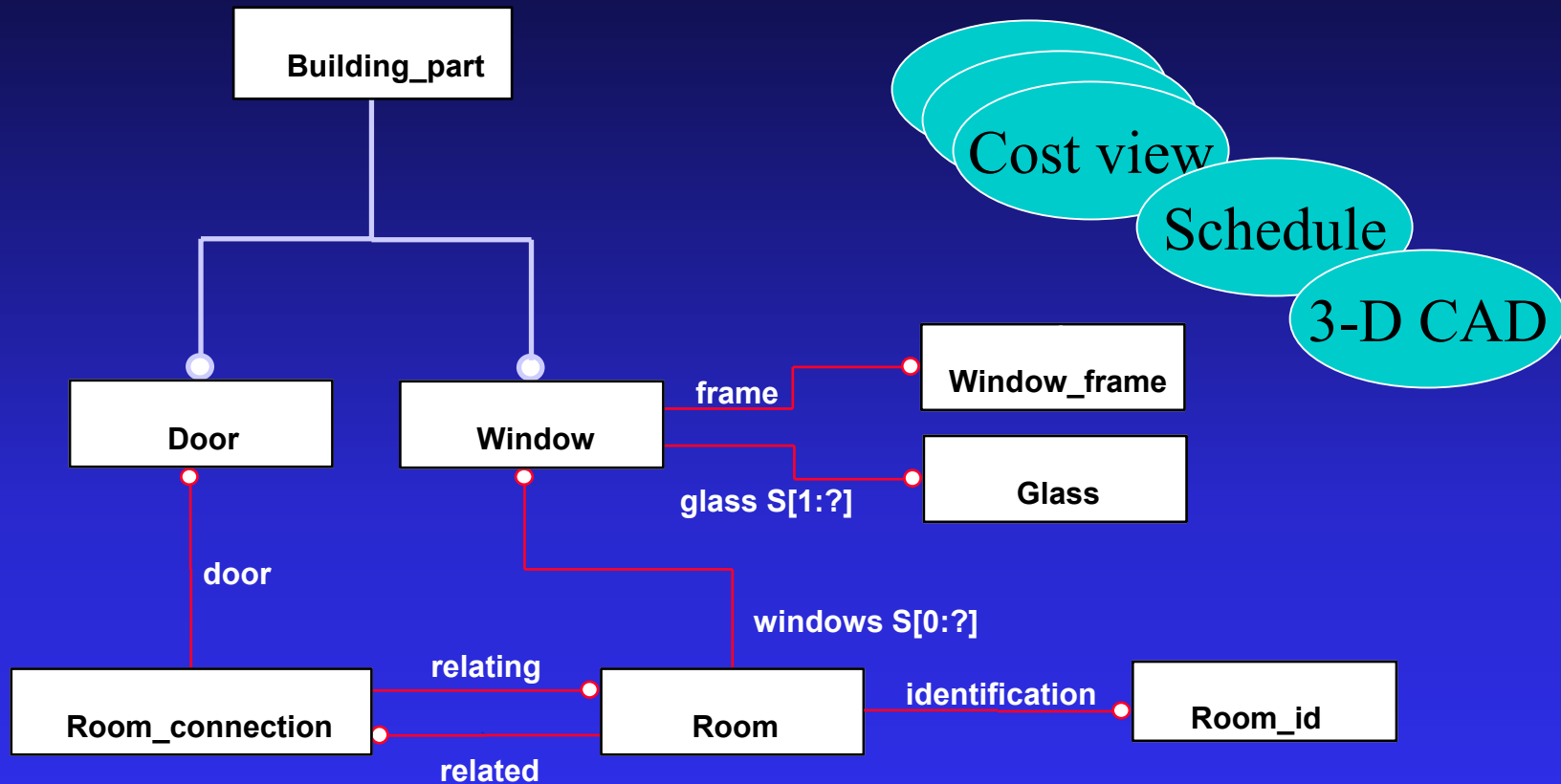


Also non-tangible information



Sectional information

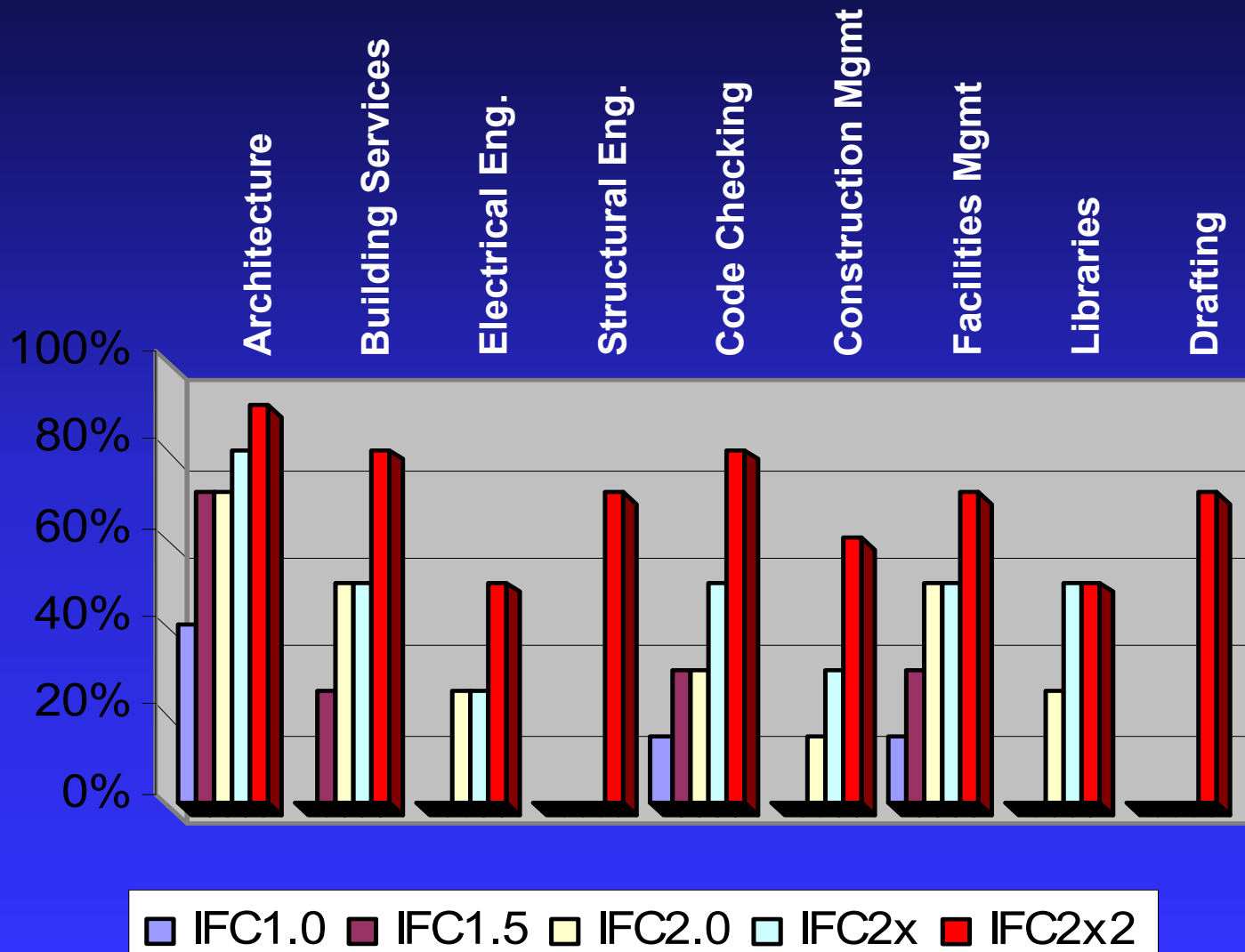
Object-oriented Modeling



International Open Standard = IFC model

IFC model – completeness (May 2003)

(relative to capabilities used in current software)



IFC 2x2: Facility Management

++ Improved asset definition

Improved allocation of time, cost and work order data

++ Simplified order provision

Improved allocation of time and cost data

++ Extended cost model

Enables costing of any object, with any type of cost, at any and all points in the lifecycle, total lifecycle cost capture, budgets, estimates, cost roll up

NEW - Condition Monitoring

Captures condition data including both measured (by Instrumentation) and assessed (by visual inspection).

NEW - Request Capture

Captures ad hoc requests made for operating and maintenance work and allocation of requests to work orders.

NEW - Service Life Data

Inclusion of capabilities for service life capture and management including reference and expected service life and ISO based service life factors.

NEW - Environmental impact

Capture of environmental impact data for objects allowing impact assessment to be carried out in support of sustainable working.

NEW - Permits

Allocation of permits for access, security, work

NEW - Operating and Maintenance information

Provision of capability to capture operating and maintenance instruction information based on the US Navy/Dept of Health developed OMSI XML standards

IFCs are “open”.
You can extend it!

Implementation of IFC model

- Database of IFC software
- Available at: www.iai-international.org
(follow the link to implementation)

Why Building Information Models (BIM)?

- Background

- ◆ Point-to-point data exchange vs. interoperability
- ◆ BIM

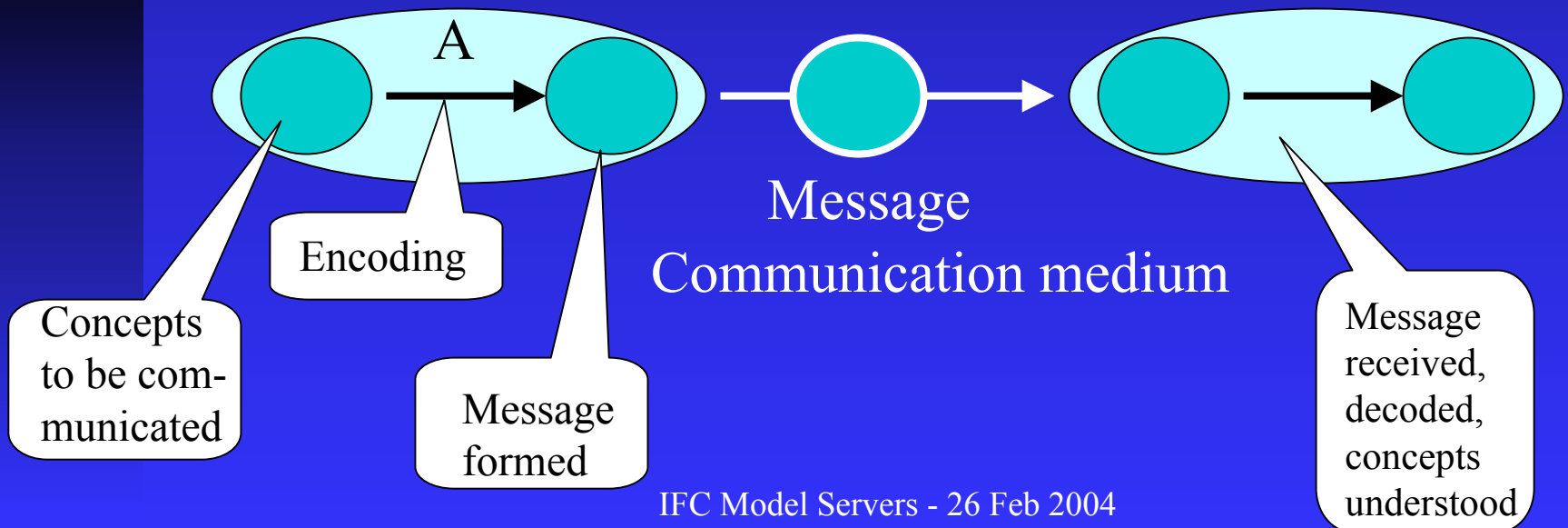
- Advantages of BIM

- Implications for FAN

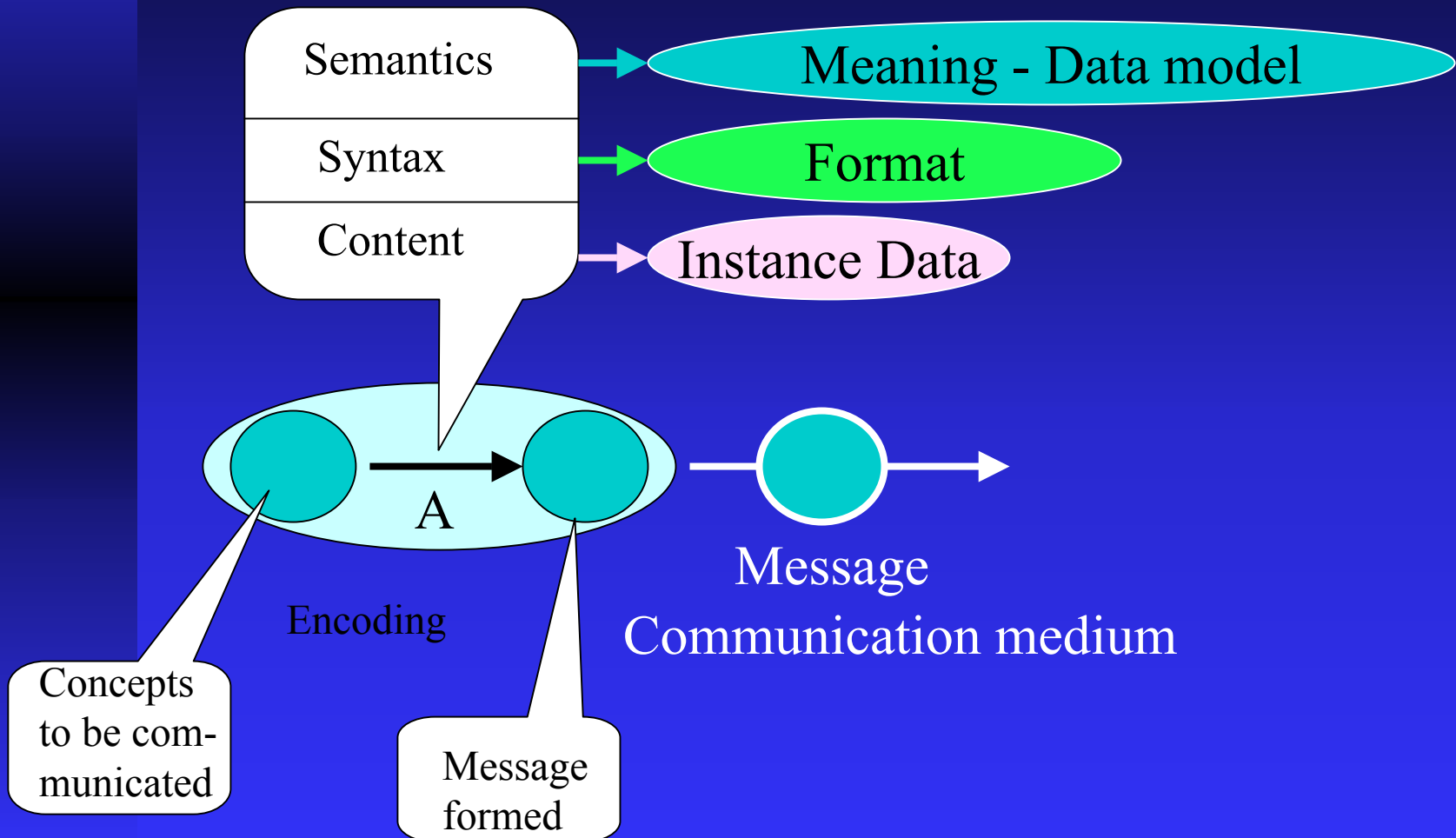
Point – to – point communication



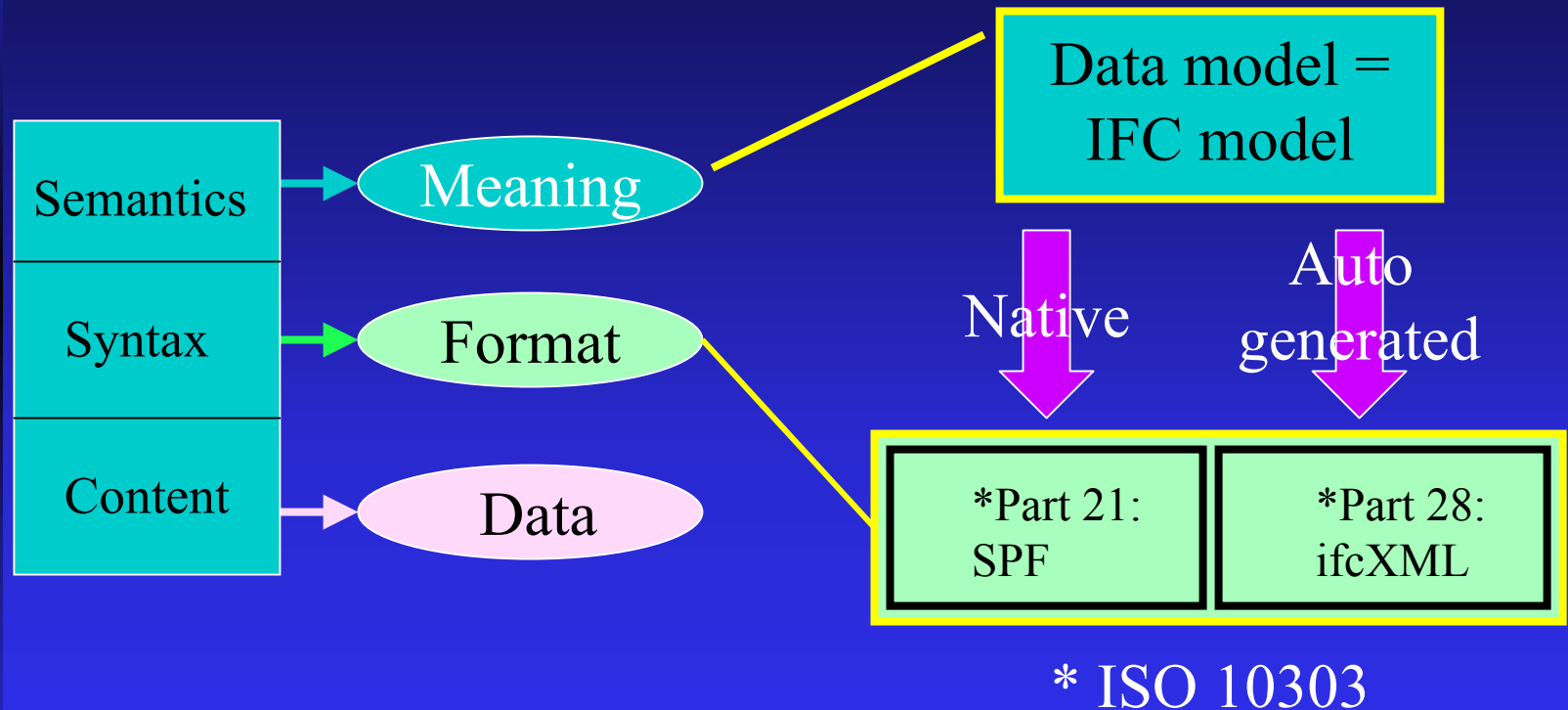
Communication is
Conveying meaning



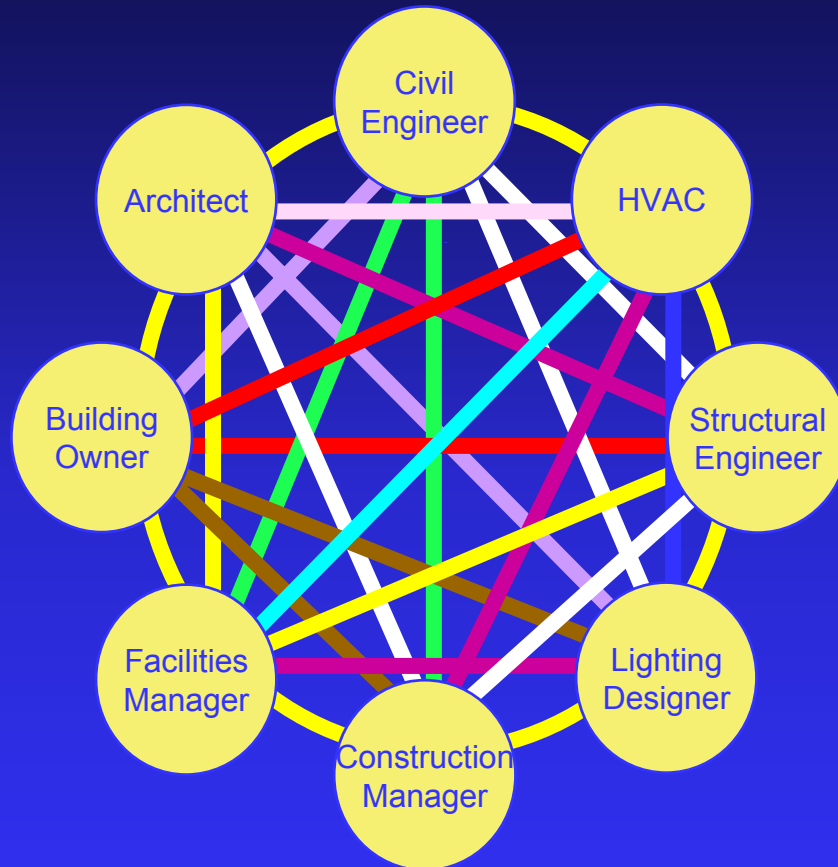
Encoding of a message



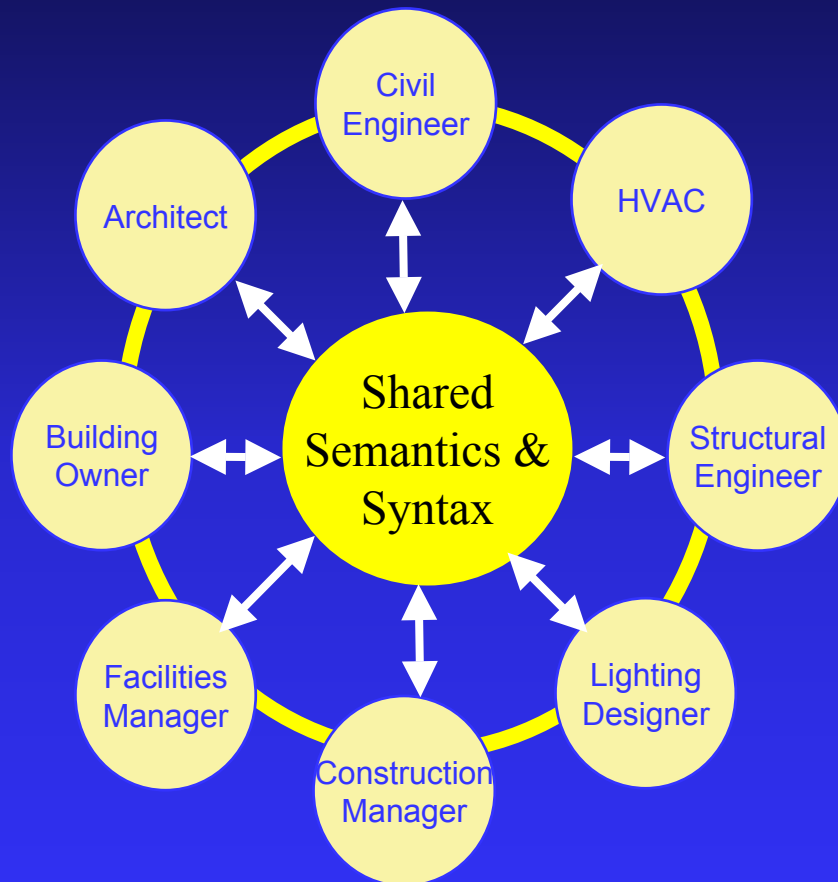
Format for IFC model data



Point – to – point communication



Agree on Semantics and Syntax:

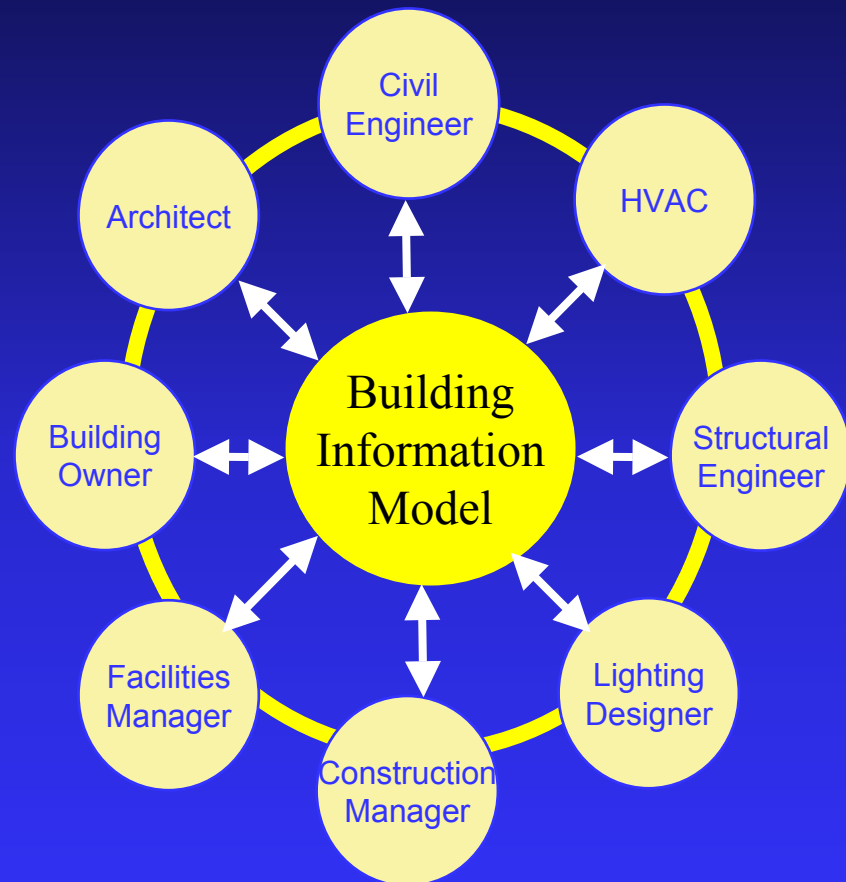


- *Participants can communicate using a common language*
- *Any participant can communicate with any other participant*
- *Facilitates high performance teams*

Agree on Semantics and Syntax AND store data in one place (virtual)

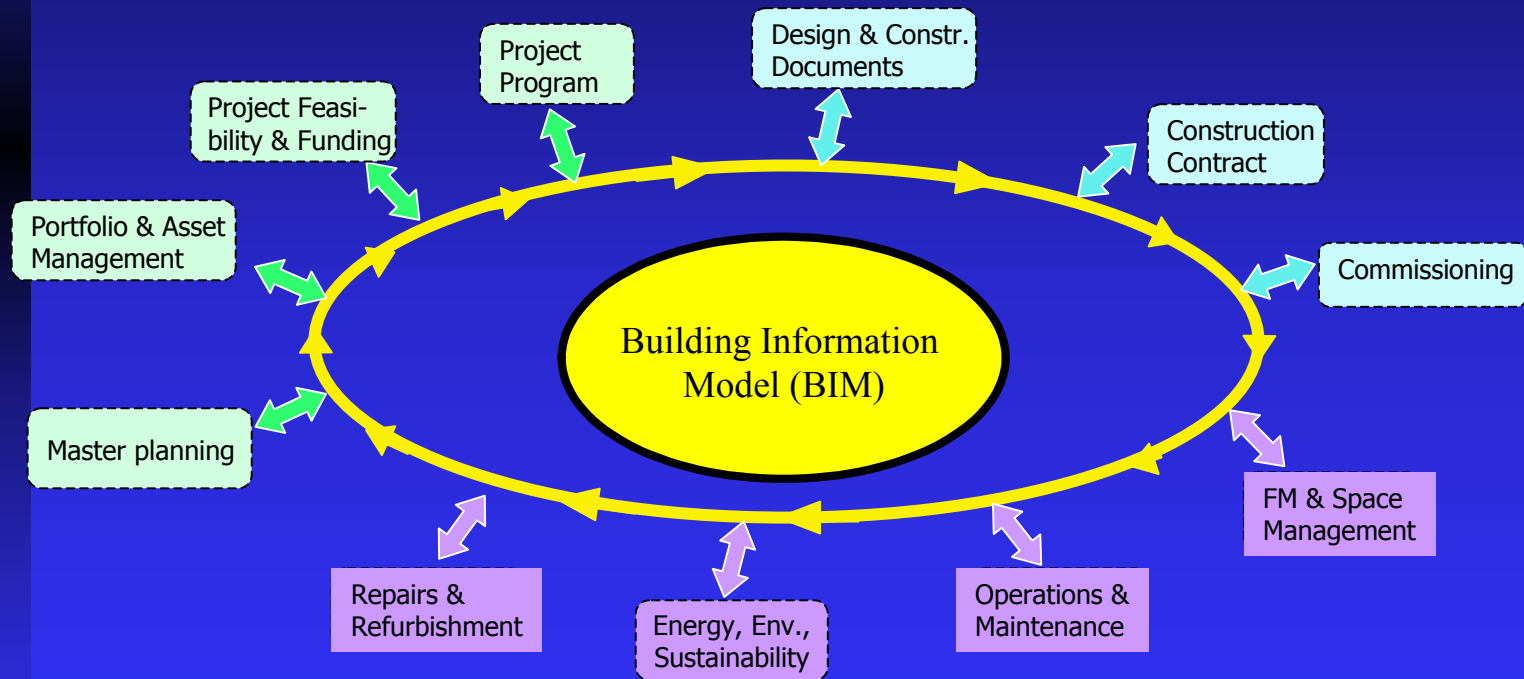
- *building information model*—an approach to documentation that dictates that all project data be stored in one and only one location. This concept is the result of a fresh look at the construction process, taking into account modern computational tools.

- Cyon Research White Paper, 2003

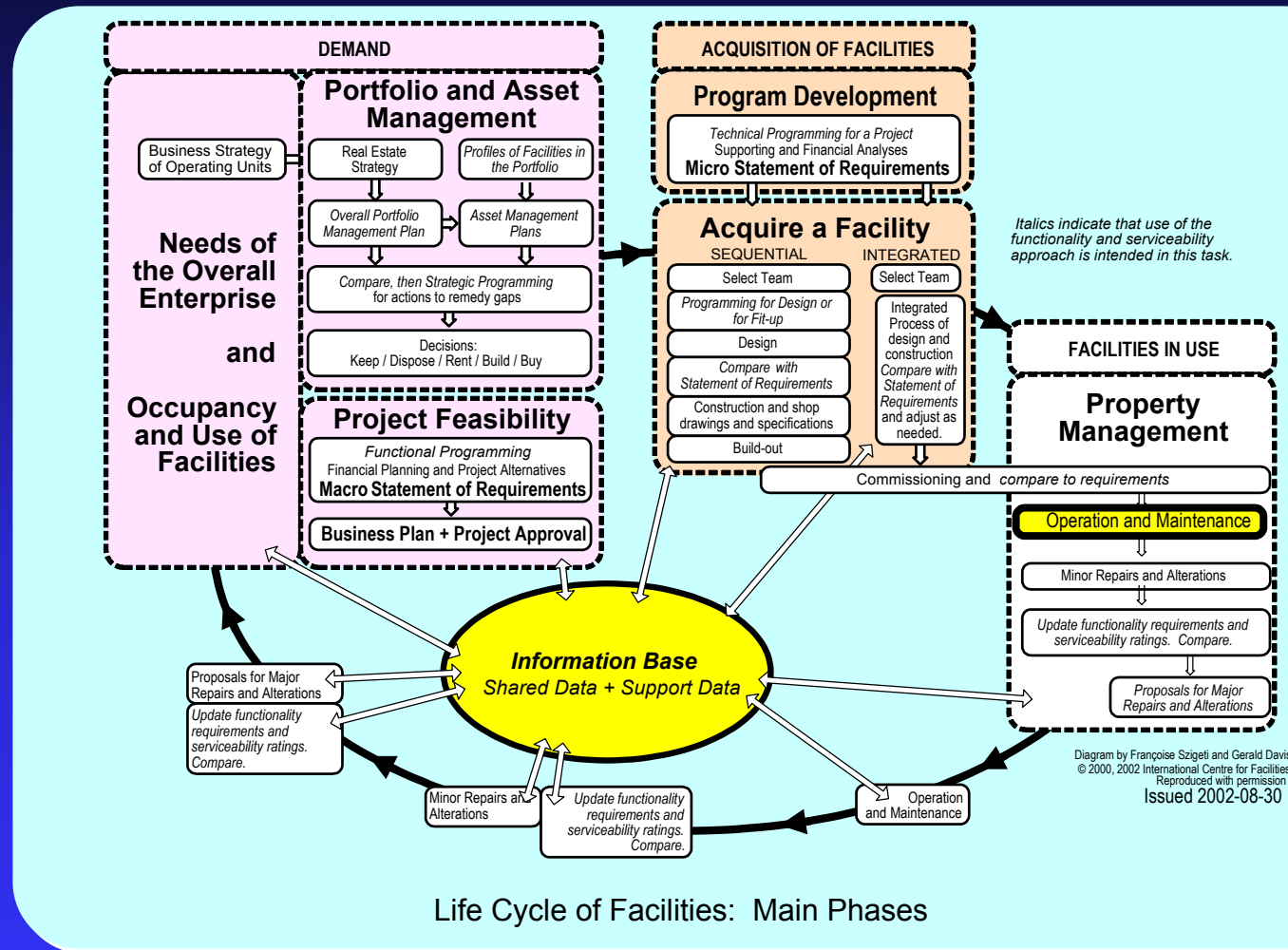


Life cycle Interoperability: BIM

“Official project/facility data” in one virtual place on internet, over life-cycle



Must deal with Facility Portfolio



Life Cycle of Facilities: Main Phases

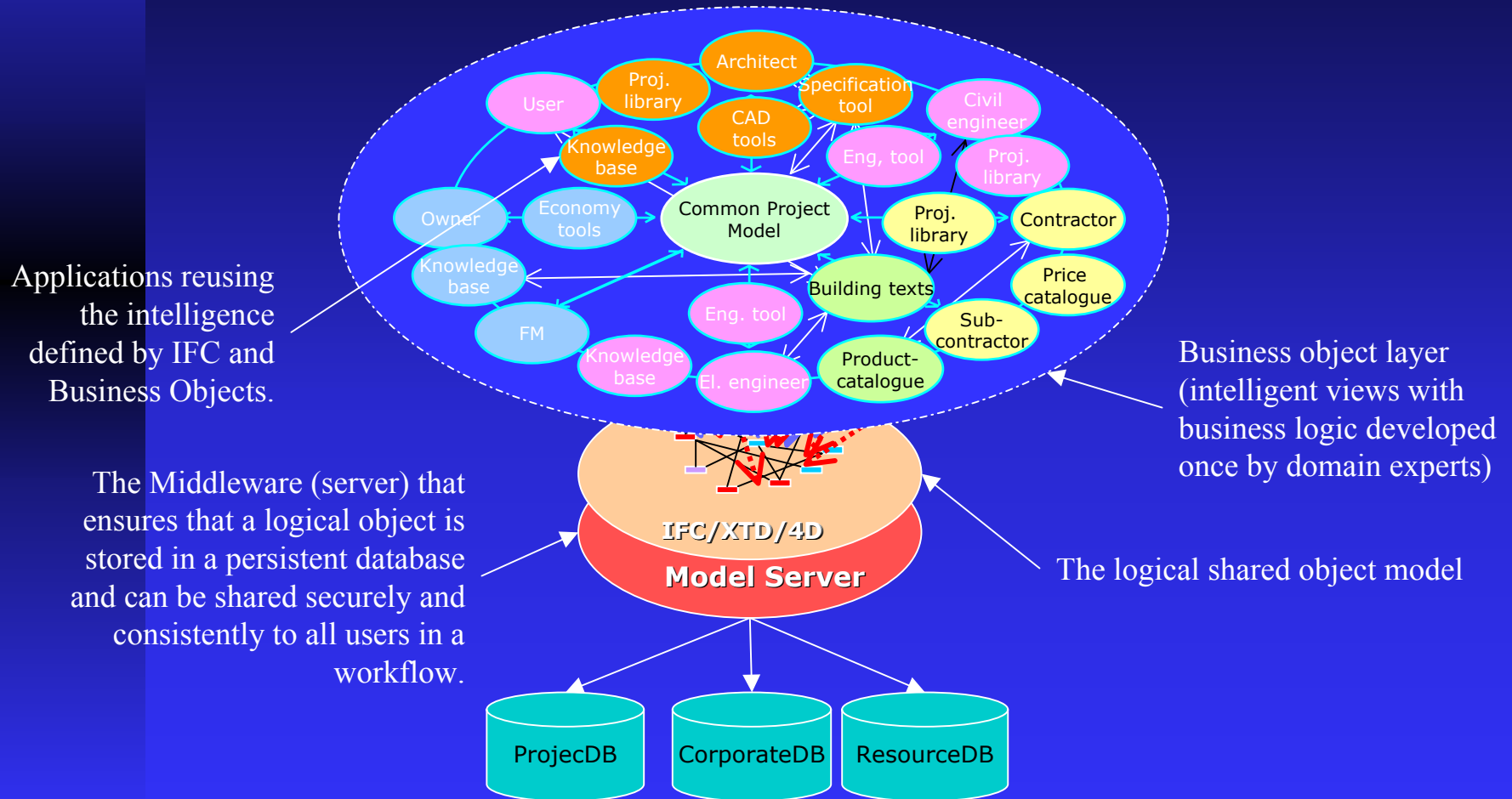
What is BIM?

“A computable representation of the physical and functional characteristics of a facility, and its related project/life-cycle information. It integrates all the relevant aspects into a coherent organization of data that computer applications can access, modify and/or add to it, if authorized to do so, using open industry standards.”

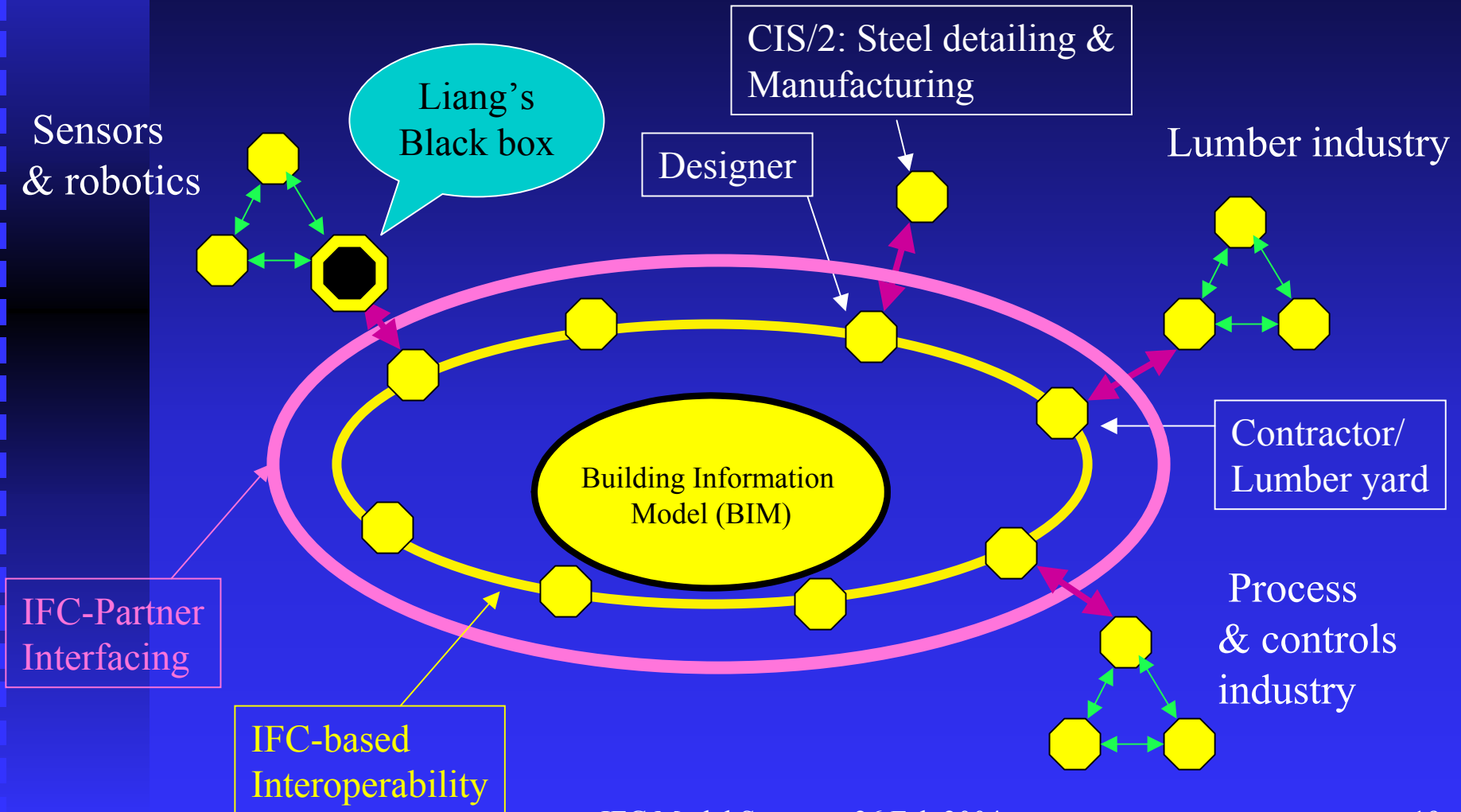
- Francois Grobler, 2004

Should be based on open standard!

Role of IFC Model Servers



IFC alignment with other models: Partner-aeXML



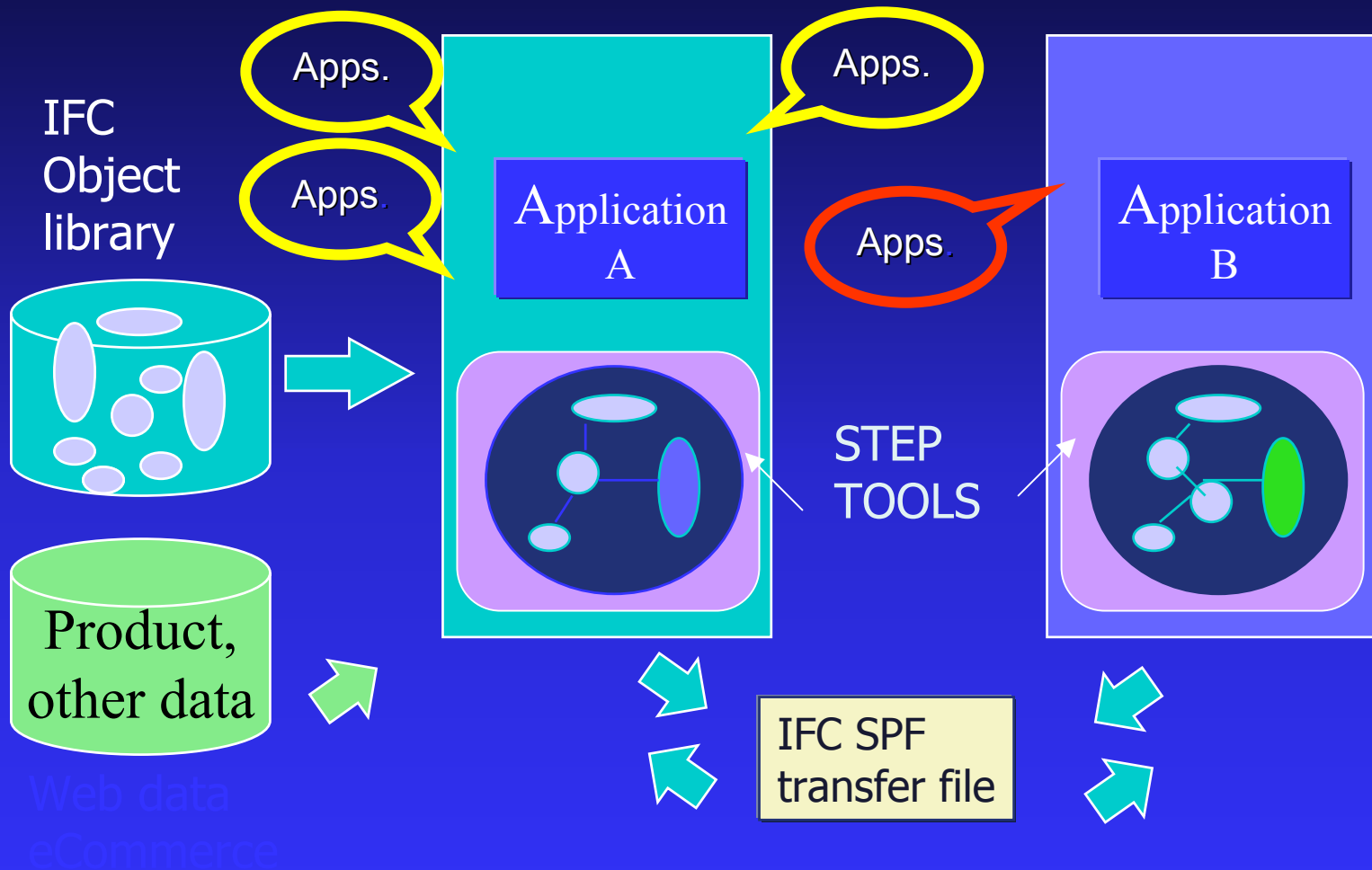
Advantages of BIM

- Facility owner owns and controls their valuable data; up-to-date, accurate, accessible
- Software is interchangeable; users in charge!
- Opportunities for process improvement
- Evolving building brain -> “smart”, self-aware
- Implications for FAN
 - ◆ Opportunity to integrate sensing and control with condition, operational information
 - ◆ Could derive data from BIM as needed
 - ◆ Contribute to BIM for use by others

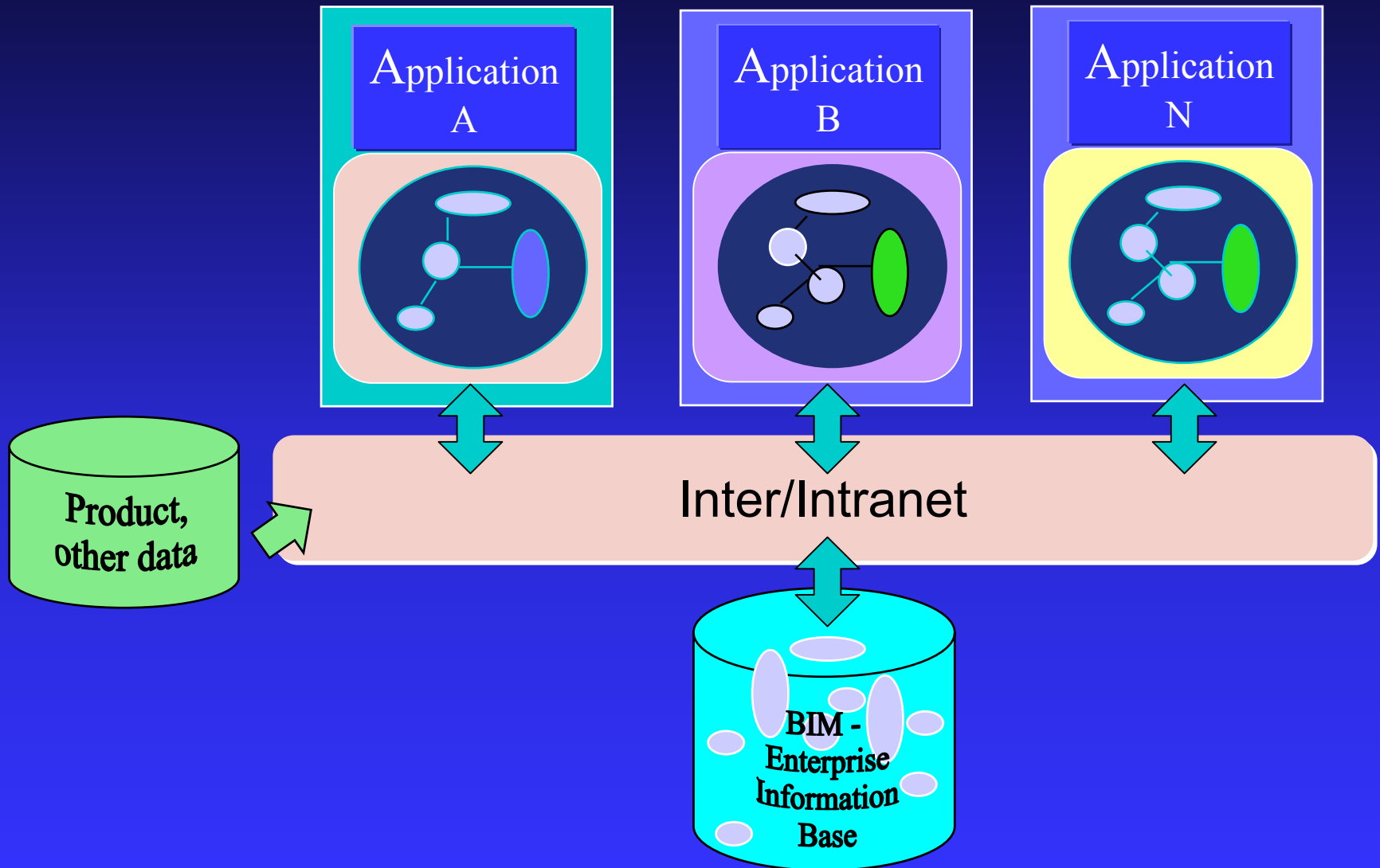
BIM standard needed

How are IFCs implemented?

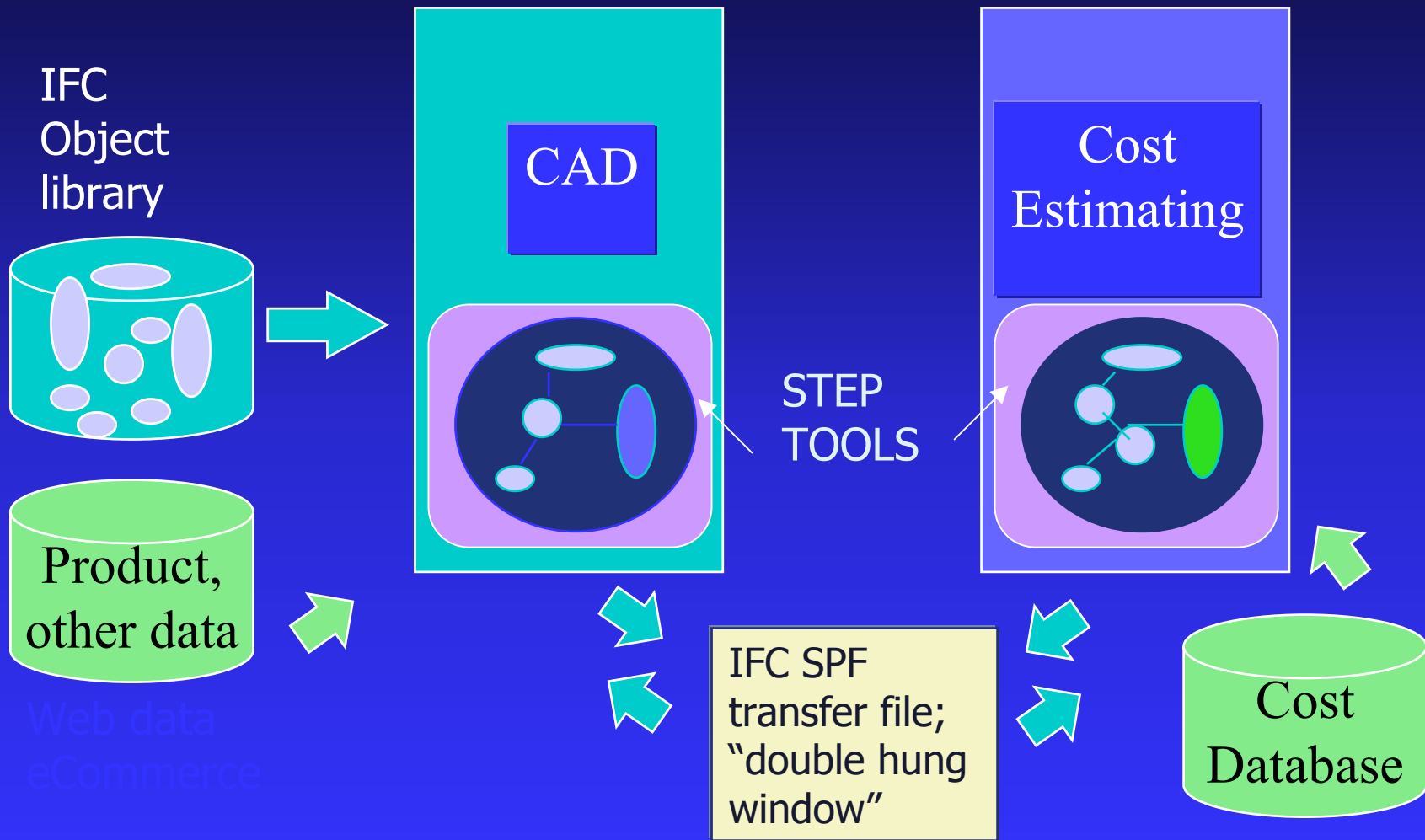
How do applications interoperate?



IFC Object Servers



Why is a new classification system necessary?



OmniClass Tables

11 - Construction Entities
 – by Function

12 - Spaces
 – by Function

13 - Construction Entities
 – by Form

14 - Spaces
 – by Form

21 - Elements (**UniFormat™**)

22 - Work Results
 (**MasterFormat™**)

23 - Products

31 - Phases

32 - Services

33 - Disciplines

34 - Organizational Roles

35 - Process Aids

41 - Information

42 - Materials

49 - Properties

See www.occsnet.org

Demonstration of Effective Information Flow in the Building Industry enabled by IFC Model Servers

AEC Systems

Orlando, 19 February 2004

**DDS NO, EPM NO, Graphisoft R&D HU, Olof
Granlund FI, Tekla Corp. FI, Solibri FI**



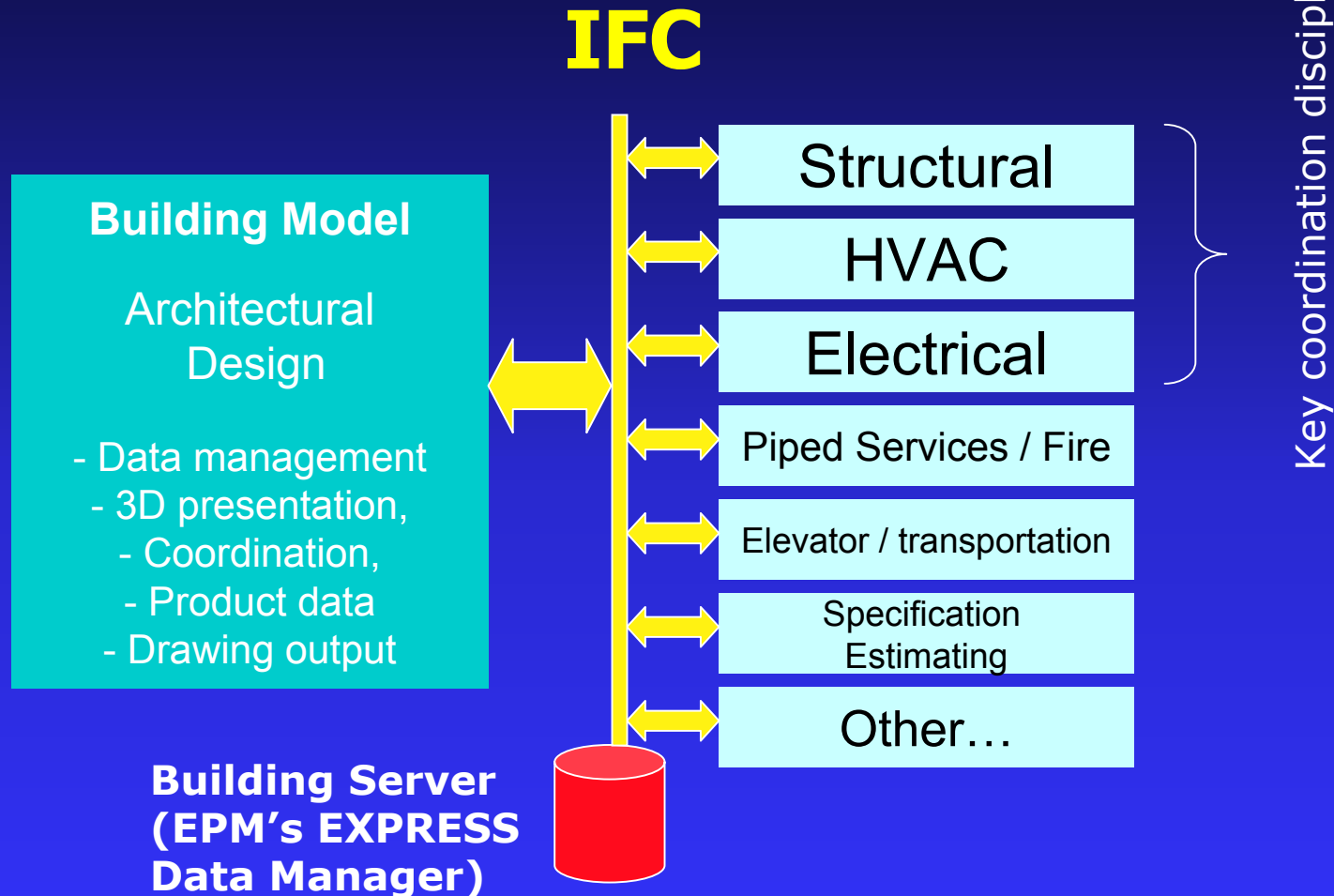
Munkerud project

Munkerud Project

- Collaboration between OBOS og Selvaagbygg through joint venture SELBOS AS
- 36 apartments in Phase I
- Søndre Nordstrand, Oslo
- Finished in 2003

Strategy for Collaboration

Strategy for collaboration

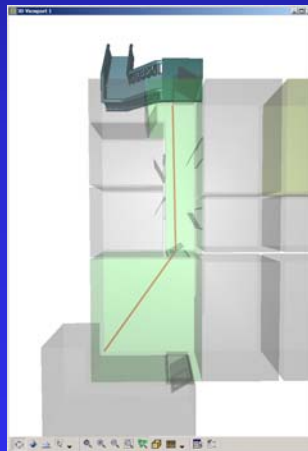


IFC Implementations

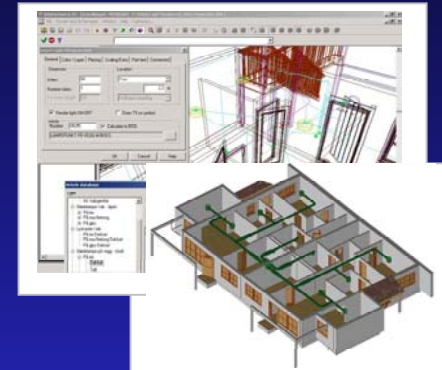
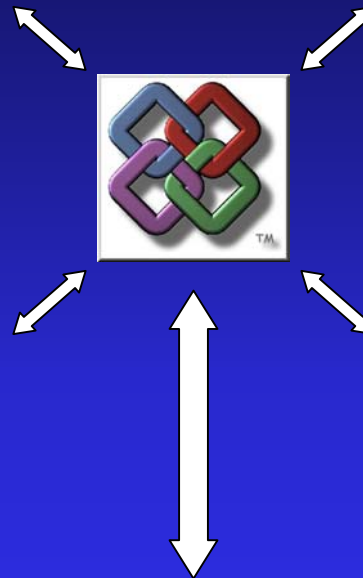
IFC Implementations



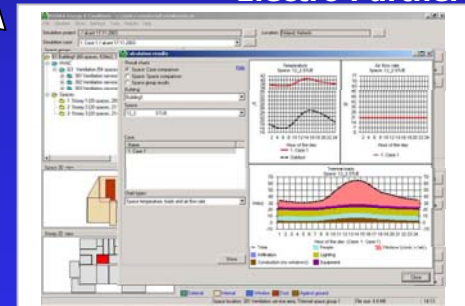
**Architecture -
ArchiCAD**



Auditing - SMC



**BS - HVAC Partner
Electro Partner**



**Energy efficiency -
Riuska**

Model	Model Name	Model Type	Model Status	Model Date	Model User	Model Version	Model Description
1	Model 1	Model 1	Model 1	Model 1	Model 1	Model 1	Model 1
2	Model 2	Model 2	Model 2	Model 2	Model 2	Model 2	Model 2
3	Model 3	Model 3	Model 3	Model 3	Model 3	Model 3	Model 3
4	Model 4	Model 4	Model 4	Model 4	Model 4	Model 4	Model 4
5	Model 5	Model 5	Model 5	Model 5	Model 5	Model 5	Model 5
6	Model 6	Model 6	Model 6	Model 6	Model 6	Model 6	Model 6
7	Model 7	Model 7	Model 7	Model 7	Model 7	Model 7	Model 7
8	Model 8	Model 8	Model 8	Model 8	Model 8	Model 8	Model 8
9	Model 9	Model 9	Model 9	Model 9	Model 9	Model 9	Model 9
10	Model 10	Model 10	Model 10	Model 10	Model 10	Model 10	Model 10

**Server -
EDMmodelServer**

Design Phases - Finland ARK95

Design Phases – Finland ARK 95

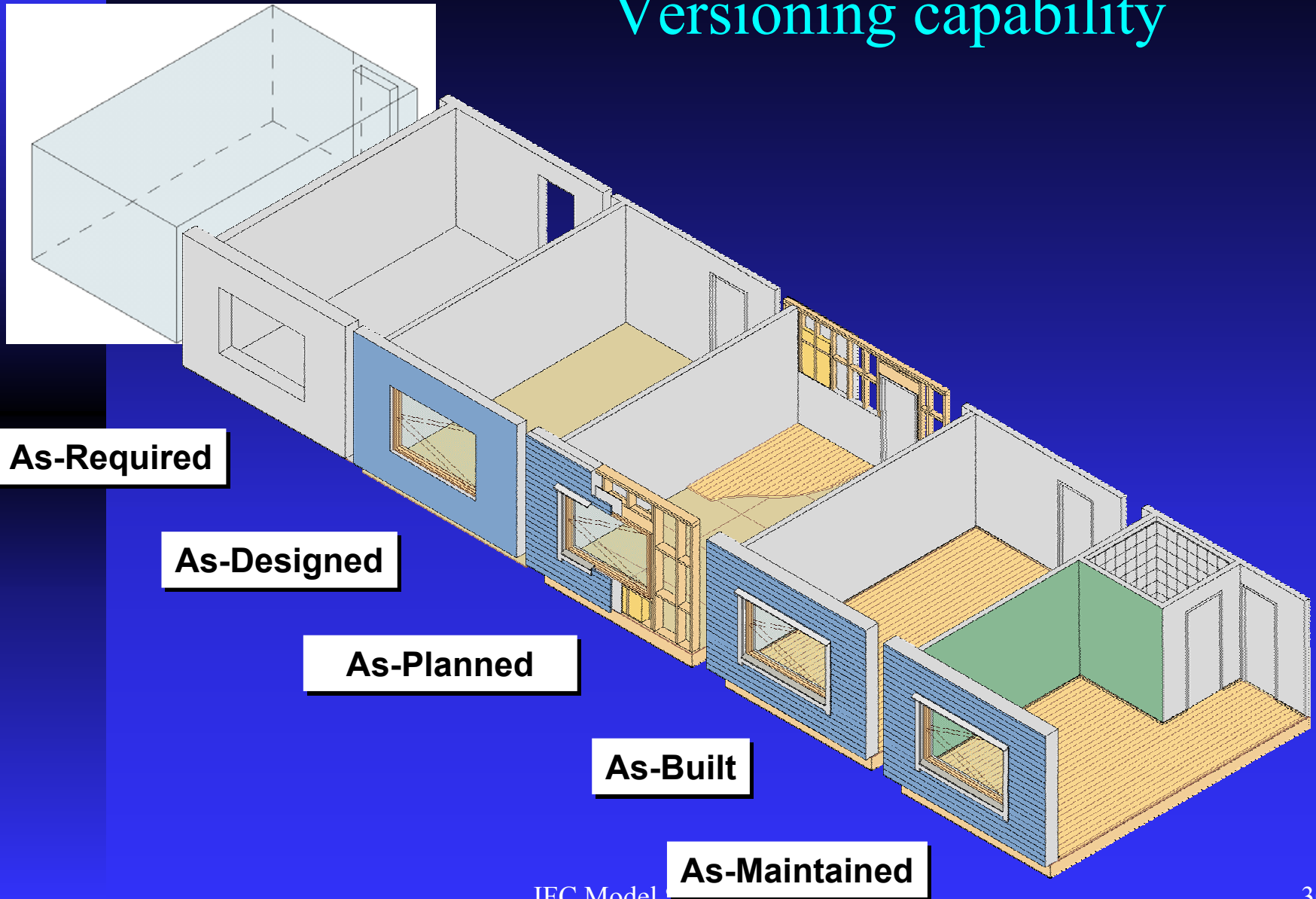
Project Stages

1. Facility study
2. Project planning
3. Overall design
4. Detailed design
5. Construction
6. Commissioning

Models

1. Requirements Model
2. Spatial Model
3. Element Model
4. Documentation Model
5. Construction Model
6. Operations Model

IFC Model Server provides Versioning capability



2021 Munkerud project

2021 Munkerud project

3	8318	8319	8320	8321
2	8214	8215	8216	8217
1	8110	8111	8112	8113



Byggetrinn I (36 units)

House 6 – 2U 2 (6 units)

House 7 – 3G 4 (12 units)

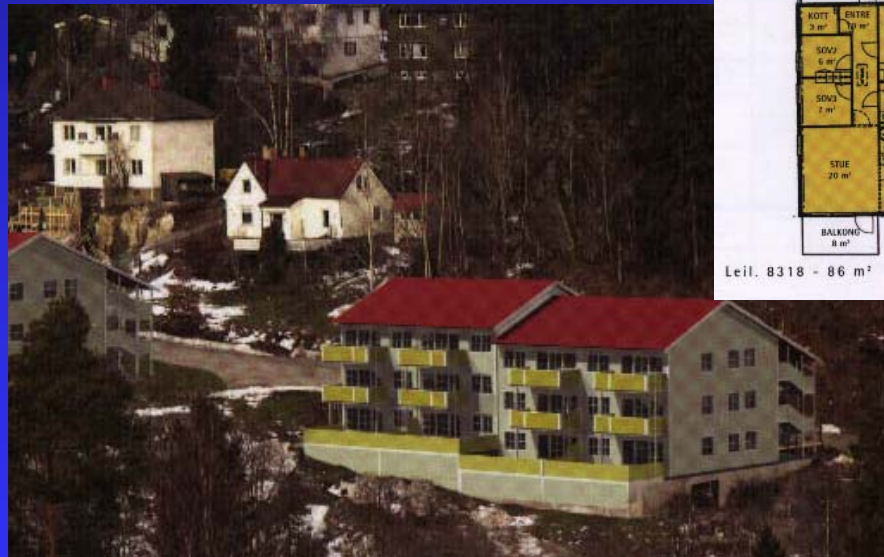
House 8 – 3G 2V2 (18 units)

FASADE MOT ØST

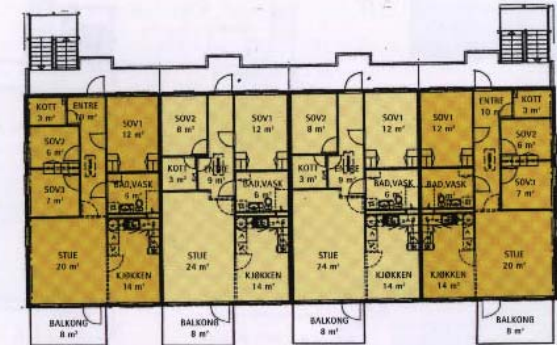


Lei

FASADE MOT SYD



PLAN 3. ETG.



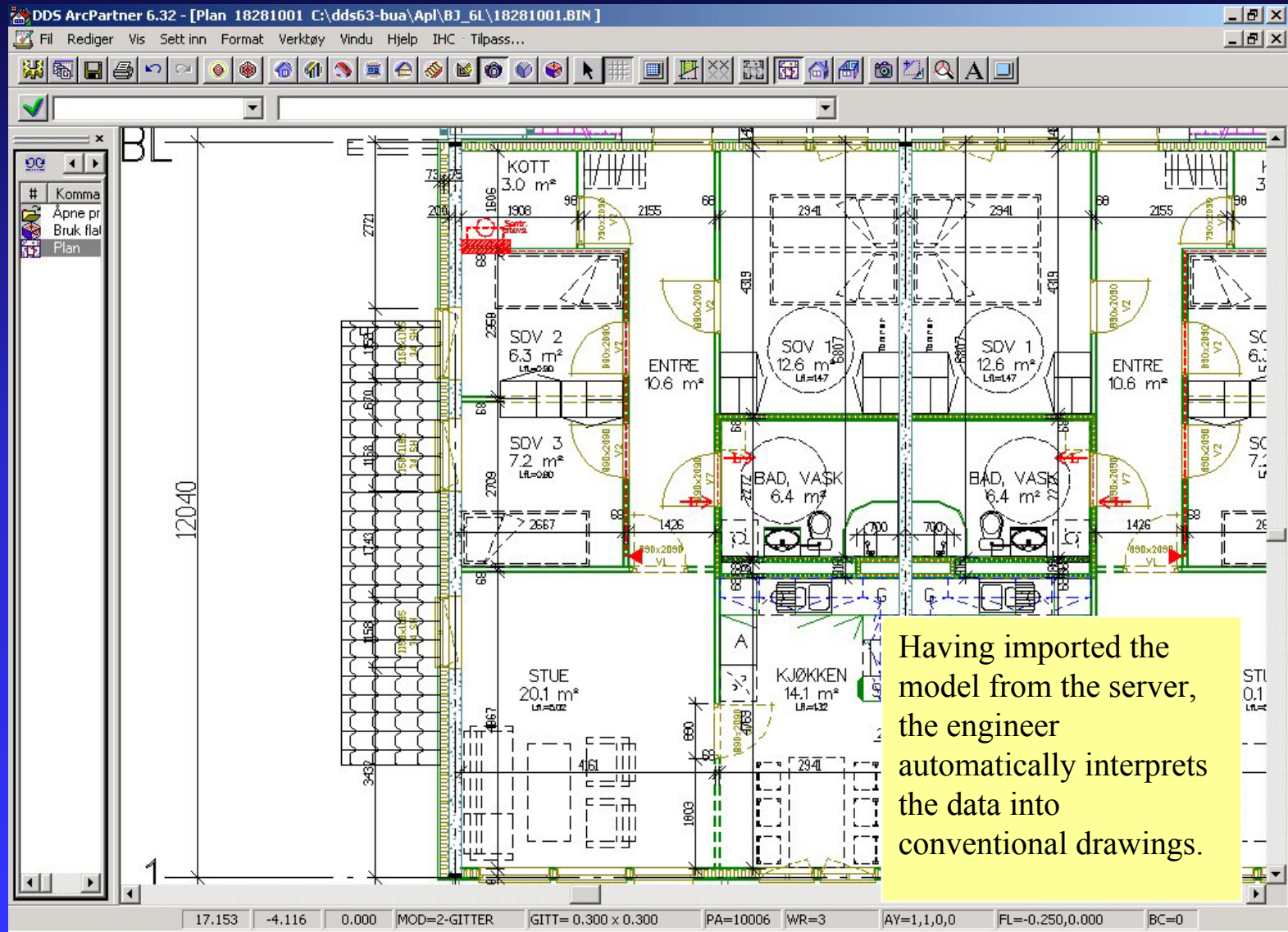
Leil. 8318 - 86 m²

Leil. 8319 - 82 m²

Leil. 8320 - 82 m²

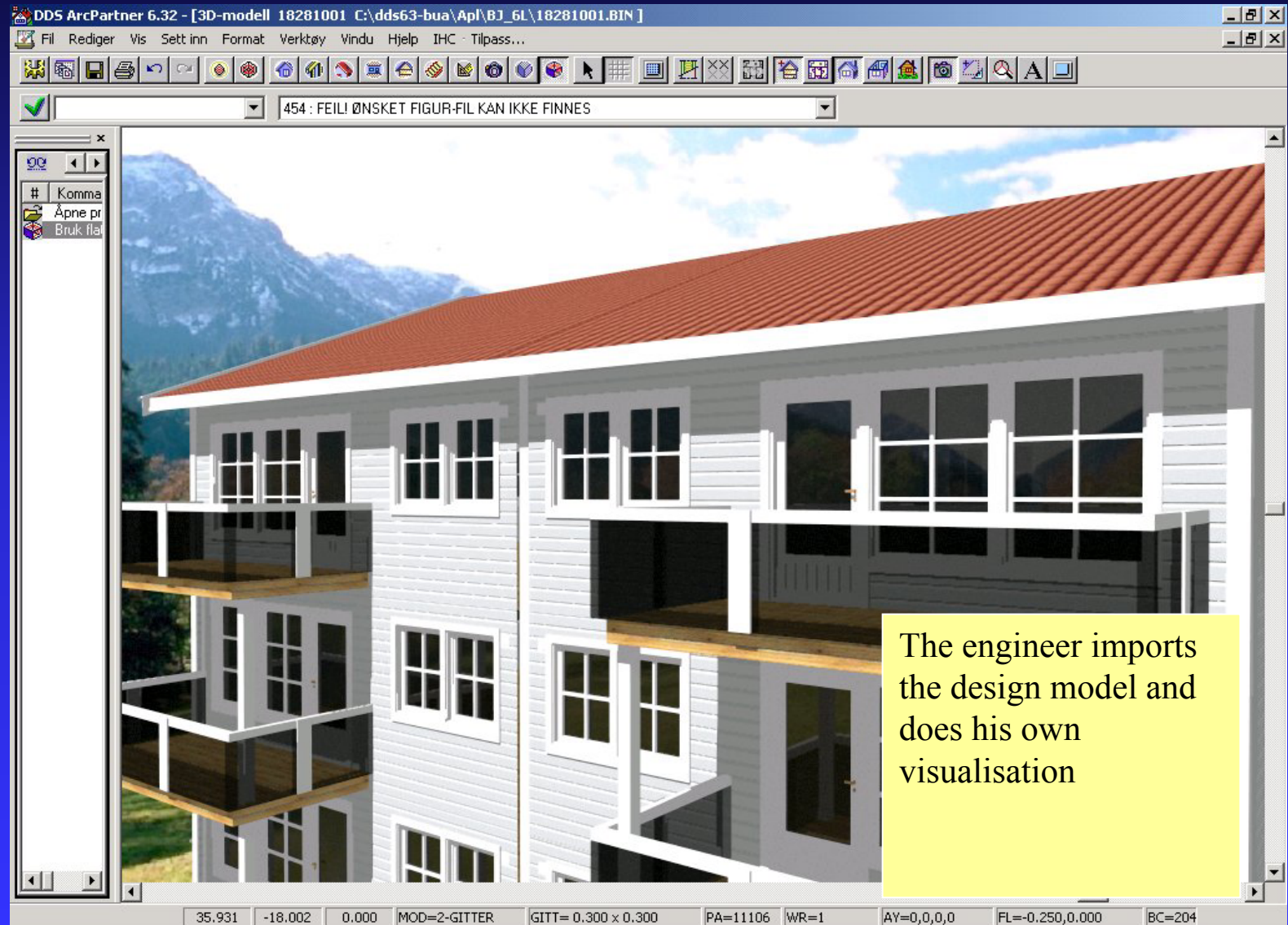
Leil. 8321 - 86 m²

DDS Ark Partner - Drawings



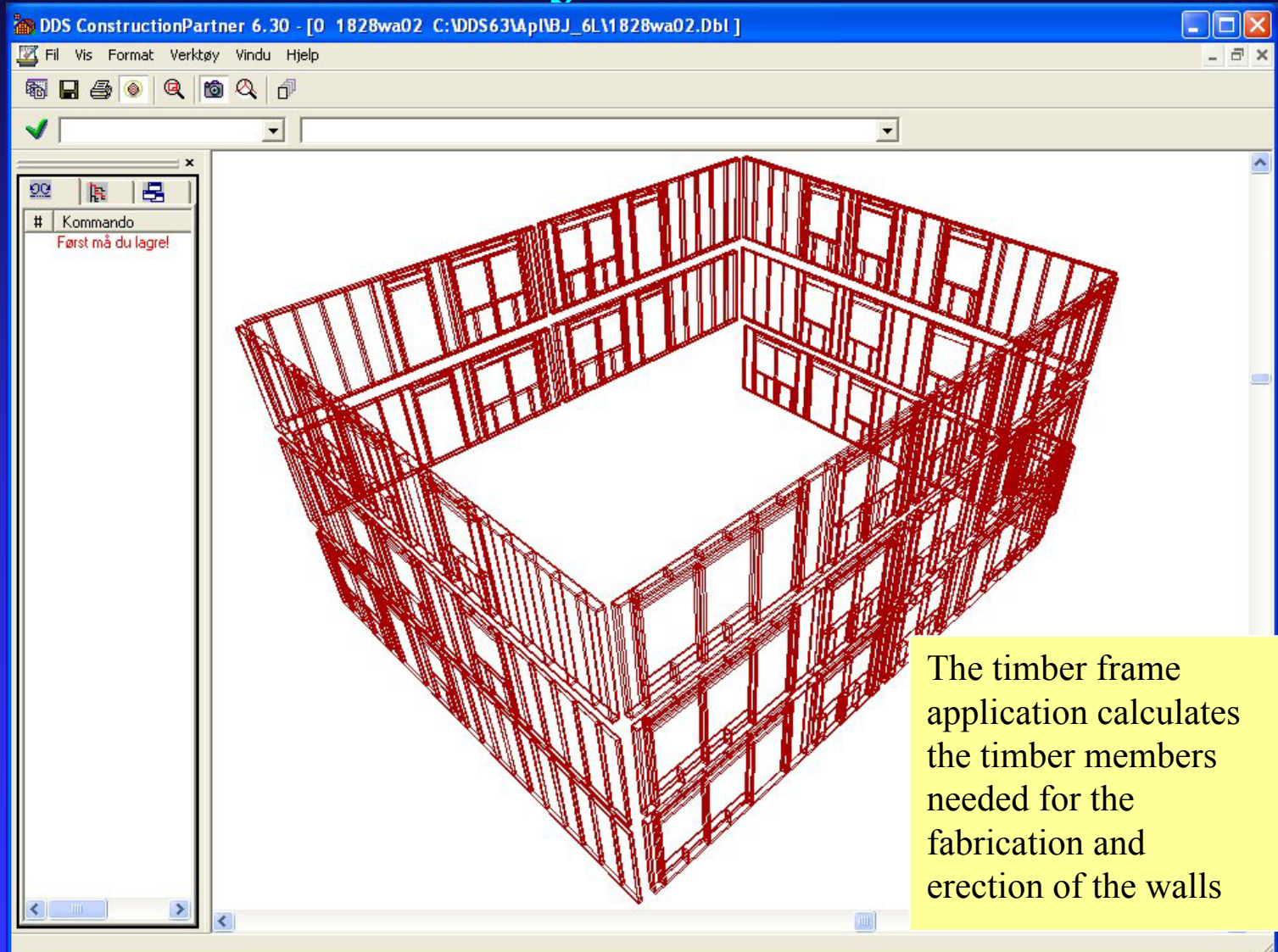
DDS Ark Partner - detail visualisation

Visualisation



Timber Frame Detailing - ST5

DDS Konstruksjons Partner



Construction drawings

DDS Konstruksjons Partner

DDS ConstructionPartner 6.30 - [Main 18282501 C:\dds63\Ap\BJ_6L\18282501.BIN]

File Endre Vis Sett inn Format Verktøy Vindu Hjelp

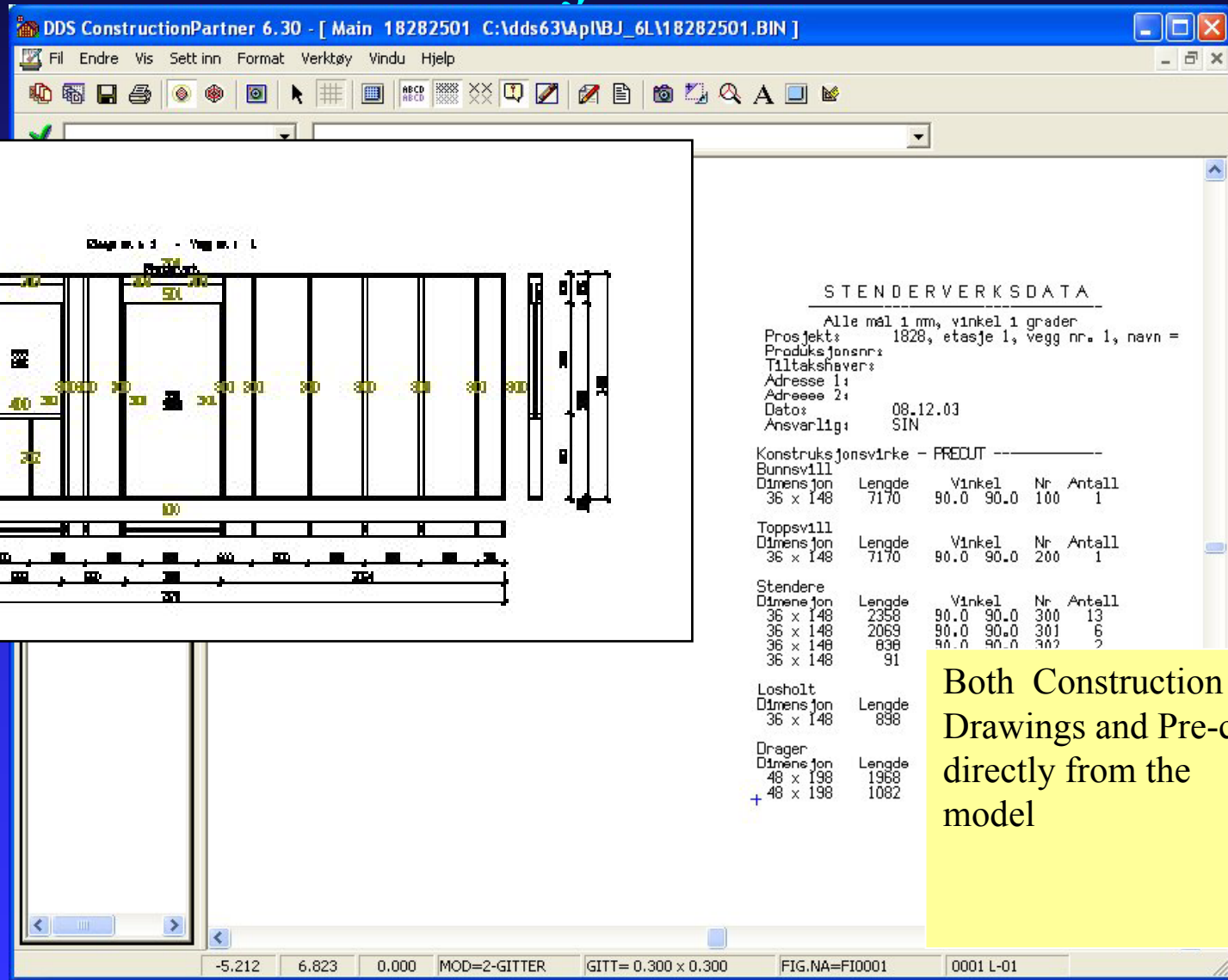


Diagram 1 - Vegg nr. 1

STENDERVERKS DATA

Alle mål 1 mm, vinkel 1 grader

Prosjekt: 1828, etasje 1, vegg nr. 1, navn =

Produksjonsnr:

Tiltakshever:

Adresse 1:

Adresse 2:

Dato: 08.12.03

Ansvarlig: SIN

Konstruksjonsvirke - PRECUT -----

Bunnsvill

Dimensjon	Lengde	Vinkel	Nr	Antall
36 x 148	7170	90.0	90.0	100
				1

Toppsvill

Dimensjon	Lengde	Vinkel	Nr	Antall
36 x 148	7170	90.0	90.0	200
				1

Stendere

Dimensjon	Lengde	Vinkel	Nr	Antall
36 x 148	2358	90.0	90.0	300
36 x 148	2069	90.0	90.0	301
36 x 148	838	90.0	90.0	302
36 x 148	91			

Losholt

Dimensjon	Lengde
36 x 148	838

Drager

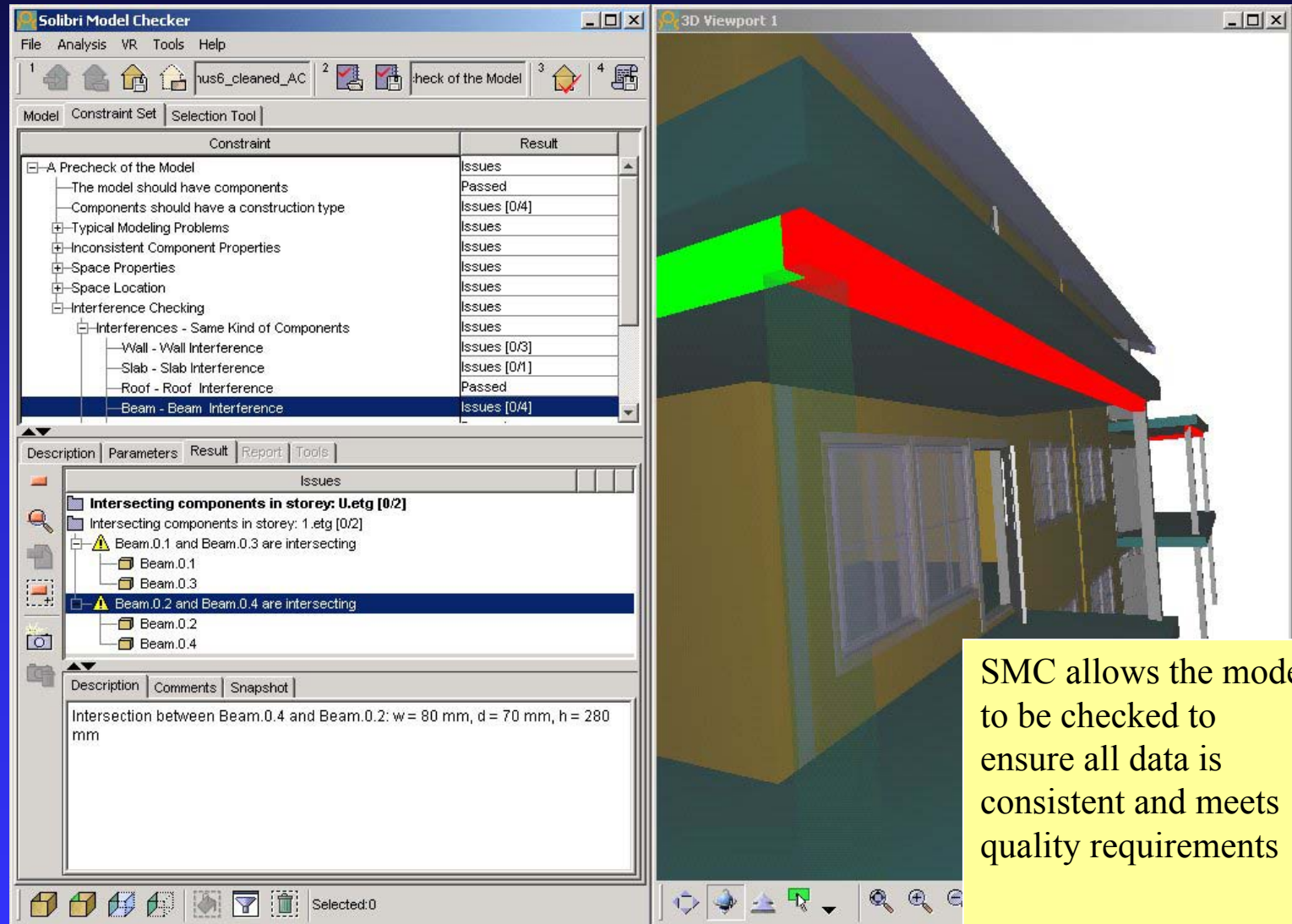
Dimensjon	Lengde
48 x 198	1968
48 x 198	1082

-5.212 6.823 0.000 MOD=2-GITTER GITT= 0.300 x 0.300 FIG.NA=FI0001 0001 L-01

Both Construction Drawings and Pre-cut directly from the model

Checking the Building Model

Solibri Model Checker



The screenshot displays the Solibri Model Checker application. The main window is divided into two panes. The left pane, titled 'Solibri Model Checker', contains a menu bar (File, Analysis, VR, Tools, Help) and a toolbar. Below the toolbar is a tree view showing the model structure. The right pane, titled '3D Viewport 1', shows a 3D rendering of a building model with a red beam highlighted.

The tree view in the left pane shows the following structure:

- Model
 - Constraint Set
 - Selection Tool

The 'Constraint Set' pane shows a table of constraints and their results:

Constraint	Result
A Precheck of the Model	Issues
The model should have components	Passed
Components should have a construction type	Issues [0/4]
Typical Modeling Problems	Issues
Inconsistent Component Properties	Issues
Space Properties	Issues
Space Location	Issues
Interference Checking	Issues
Interferences - Same Kind of Components	Issues
Wall - Wall Interference	Issues [0/3]
Slab - Slab Interference	Issues [0/1]
Roof - Roof Interference	Passed
Beam - Beam Interference	Issues [0/4]

The 'Issues' pane shows the following details:

- Issues
 - Intersecting components in storey: U.etg [0/2]
 - Intersecting components in storey: 1.etg [0/2]
 - Beam.0.1 and Beam.0.3 are intersecting
 - Beam.0.1
 - Beam.0.3
 - Beam.0.2 and Beam.0.4 are intersecting
 - Beam.0.2
 - Beam.0.4

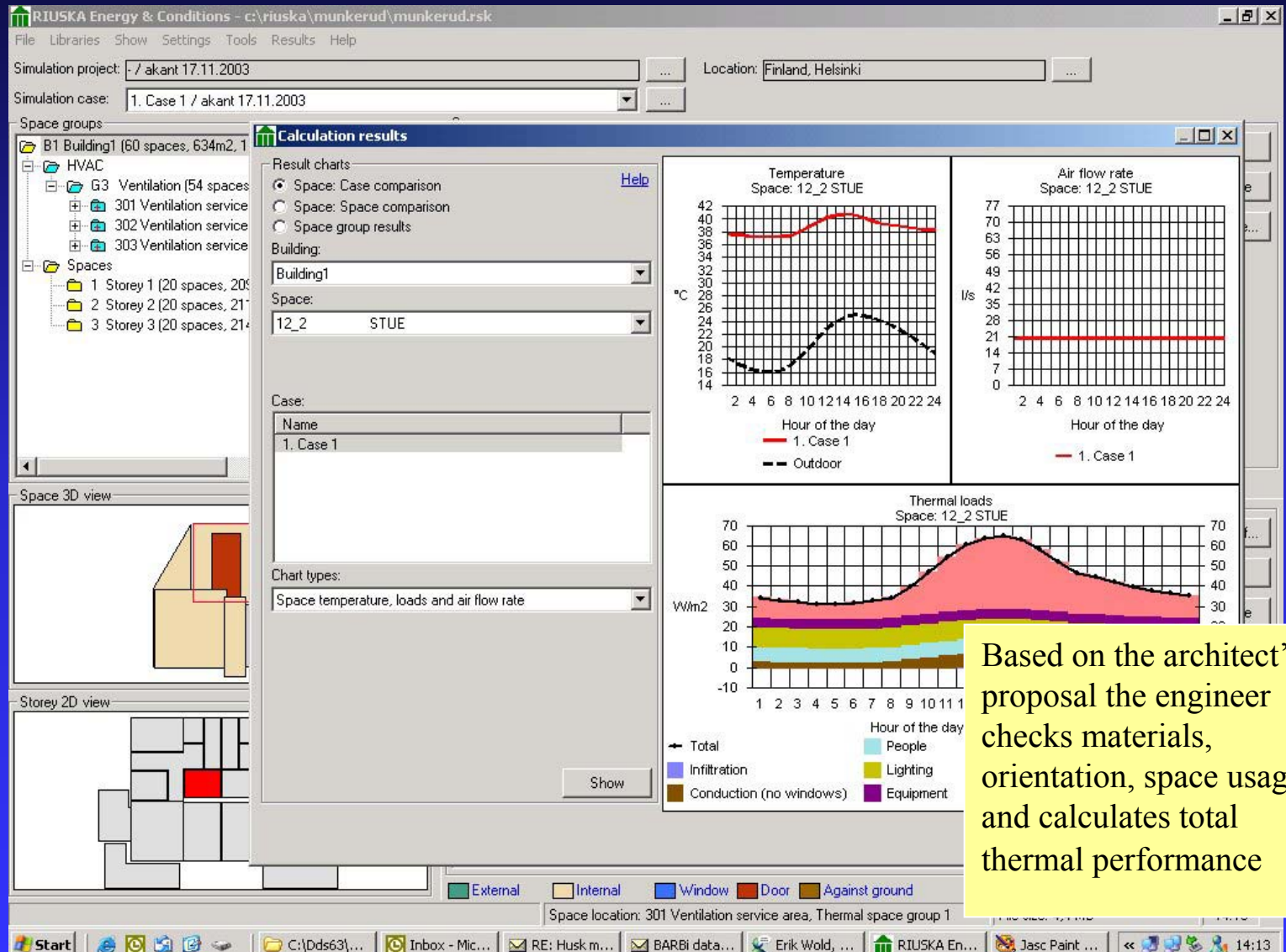
The 'Description' pane shows the following details:

- Description
 - Intersection between Beam.0.4 and Beam.0.2: w = 80 mm, d = 70 mm, h = 280 mm

SMC allows the model to be checked to ensure all data is consistent and meets quality requirements

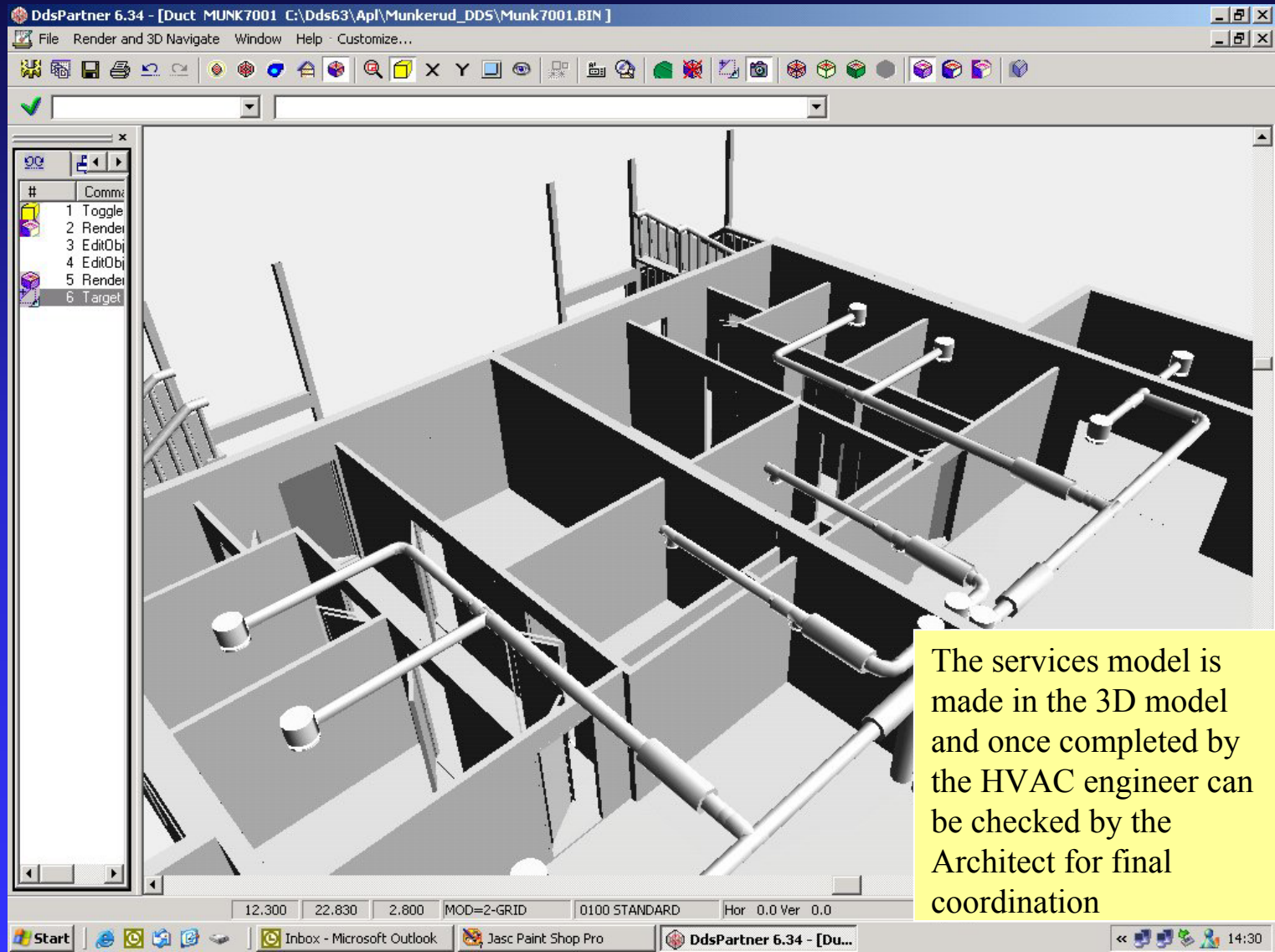
Energy performance

Olof Granlund Riuska



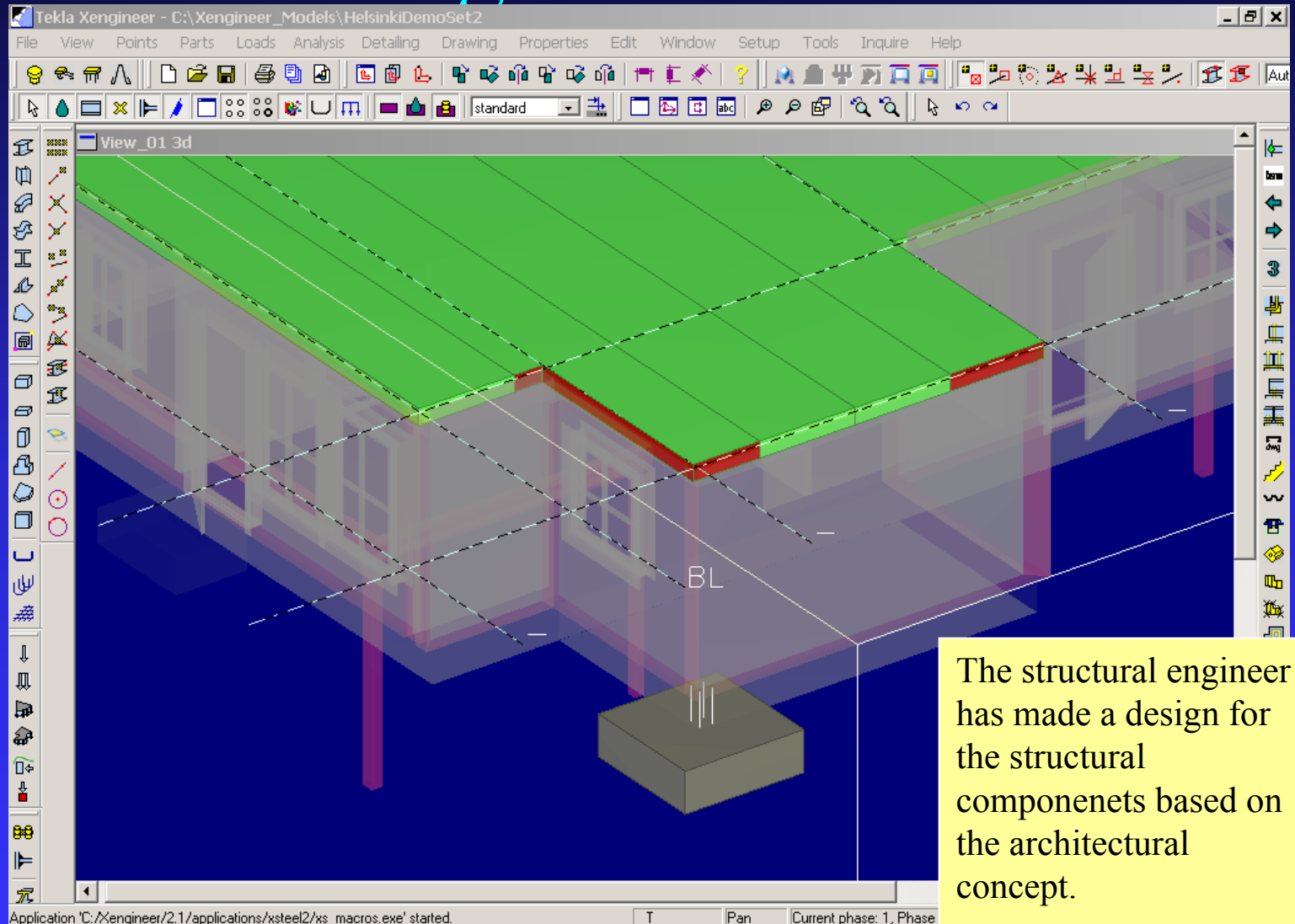
Based on the architect's proposal the engineer checks materials, orientation, space usage and calculates total thermal performance

Project HVAC system DDS VVS Partner



Structural System

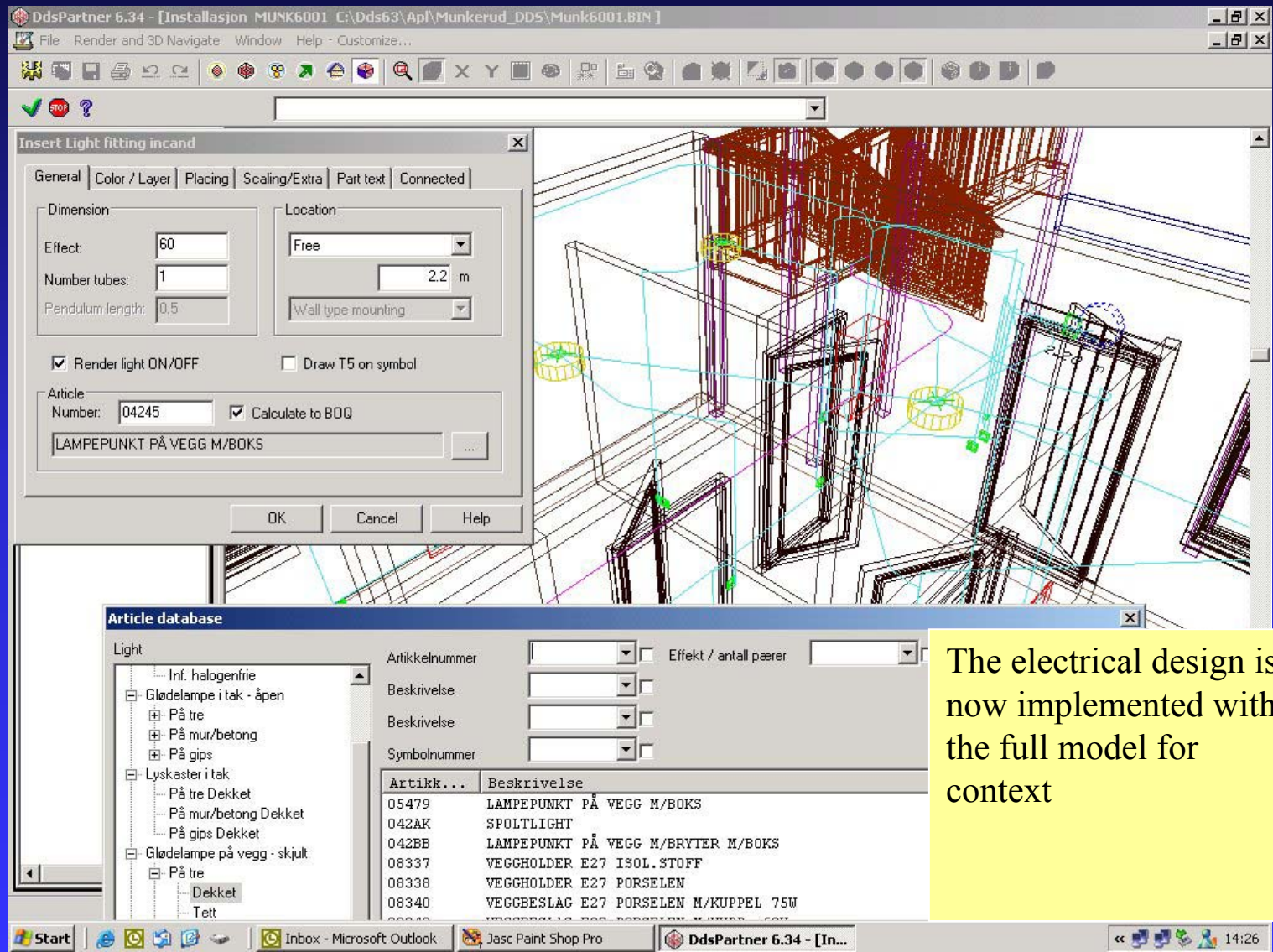
Tekla - Xengineer/Xsteel



The structural engineer has made a design for the structural components based on the architectural concept.

Building electrical services

DDS Elektro Partner



The electrical design is now implemented with the full model for context

Building services - full integration

Complete building services

The screenshot displays the DdsPartner 6.34 software interface. The top menu bar includes File, Edit, View, Insert, Format, Components, Circuit, Symbol text, Tools, Window, and Help - Customize... The toolbar contains various icons for file operations, editing, and viewing. The main workspace is divided into several panes:

- Duct MUNK7001**: A 3D perspective view of a duct network.
- Installasjon MUNK6001**: A 2D schematic diagram of a duct system with components labeled SOV 1 (019, 12.6 m²), SOV 2 (015, 6.2 m²), SOV 3 (014, 7.1 m²), ENTRE 012 (10.6 m²), and BAD VASK (010).
- enent MUNK8001**: A 2D schematic diagram of a room layout with various fixtures.

A **Room Dialog** window is open, showing the **Room data** tab. It contains a table with the following data:

Name	Value	Description
VentilationAirFlowrate	0.0071 m³/s	Ventilation outside air requirement.
ExhaustAirFlowrate	0.0071 m³/s	Exhaust air flow rate for the space.
TotalHeatGain	0 W	
HeatingDryBulb	20 °C	
CoolingDryBulb	27 °C	
TotalHeatLoss	210 W	

At the bottom of the Room Dialog window, there are checkboxes for ☒ General properties and ☒ Property sets.

Coordination, the most complex of current tasks now draws upon all the multi-disciplinary data available from the model server

What is the impact of IFC?

What is the impact of IFC?

- Building owner may take ownership of decisions and all information in building life cycle.
- Neutral standard provides low friction information logistics.
 - ◆ Higher information quality
 - ◆ Increase of reuse of information
 - ◆ Increase in competitive edge - locally & internationally
- Better decisions through changes

IFC Model Servers

- ❑ Definition of a Model server
- ❑ A bit of history
- ❑ IMS_{vr}
- ❑ SABLE specification

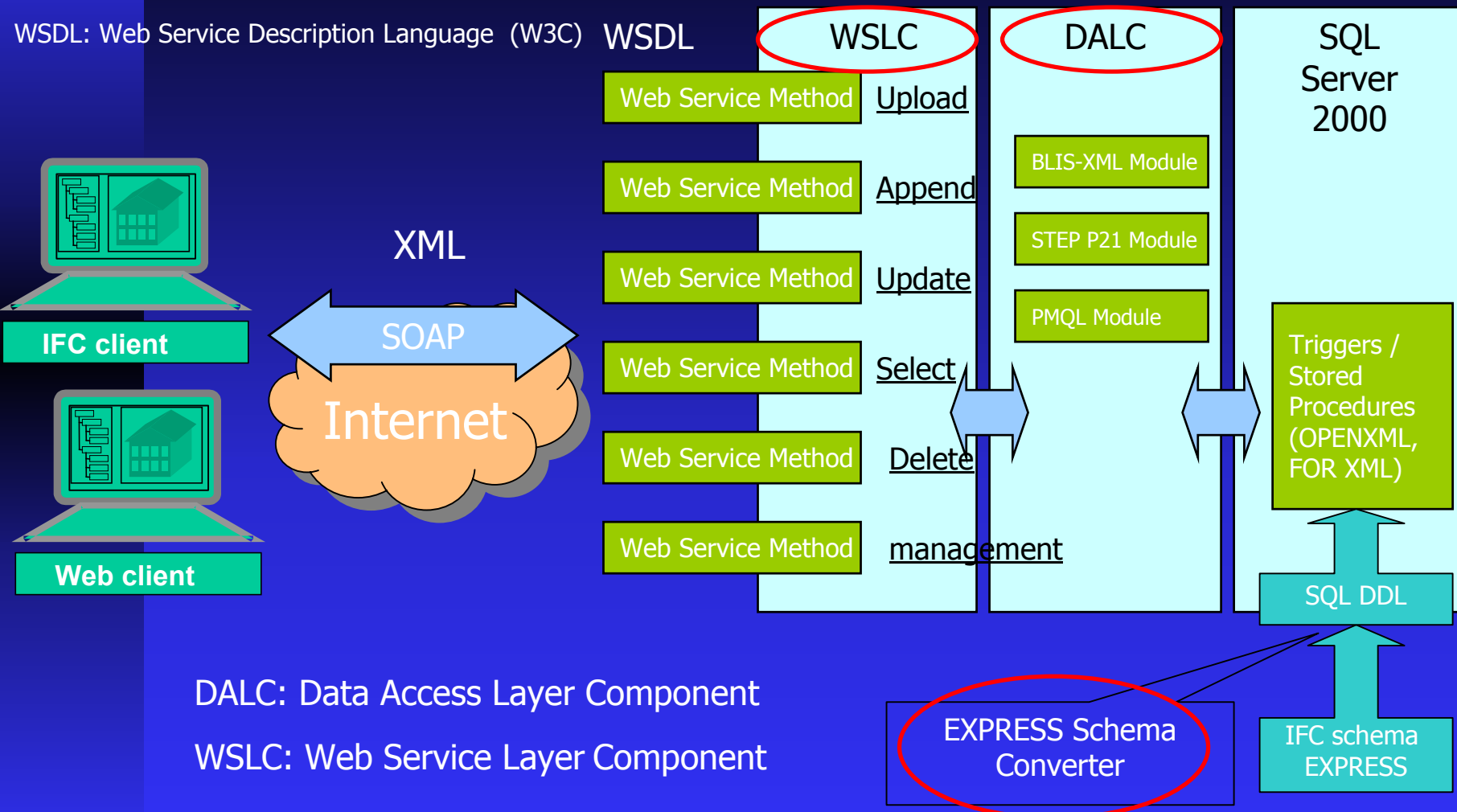
Definition of an IFC Model Server

- A persistent object repository and associated object management capabilities to provide and control access to IFC model data.
- It typically also includes methods to serve IFC objects across the Internet
- May depend on relational databases for persistent, secure storage of data.

IFC Model Servers: a Short History

- Servers were anticipated from the beginning
- Example of first generation –
 - ◆ BS Pro – Olof Granlund, Finnish Contractor
- IFC model server – Secom, Japan
- 2nd generation
 - ◆ IMSvr – collaboration between VTT & Secom
 - ◆ EuroStep – EMS
 - ◆ EPM Jotne – EXPRESS data manager (EDM)

IMSvc Architecture



DDL: Data Definition Language

IFC Model Servers - 26 Feb 2004

Brief Introduction of IMSvr Web Service Methods

- GetProjectList
 - ◆ Returns list of IFC projects stored in the model server
- GetObject
- FindObjects
 - ◆ Returns IFC objects that are specified by entity type as XML format.
- SetAttribute
- BatchExportModel
 - ◆ Returns IFC model that is specified by project name as BLIS-XML format
- RunPML
 - ◆ Returns the result of partial model query as XML or STEP P21 format.

Example of SOAP Communication between IFC Model Server and Client software

Request: Get an IFC object

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
- <SOAP-ENV:Envelope SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" xmlns:SOAP-
  ENV="http://schemas.xmlsoap.org/soap/envelope/">
- <SOAP-ENV:Body>
  - <SOAPSDK1:GetObject xmlns:SOAPSDK1="http://tempuri.org/message/">
    <strUserName>user1</strUserName>
    <strPassword>user1</strPassword>
    <strProjectName>fortum_model</strProjectName>
    <strOID>7DD99129D5FD439DAF1D1E432B47CE62</strOID>
  </SOAPSDK1:GetObject>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Parameters of Web Service Method

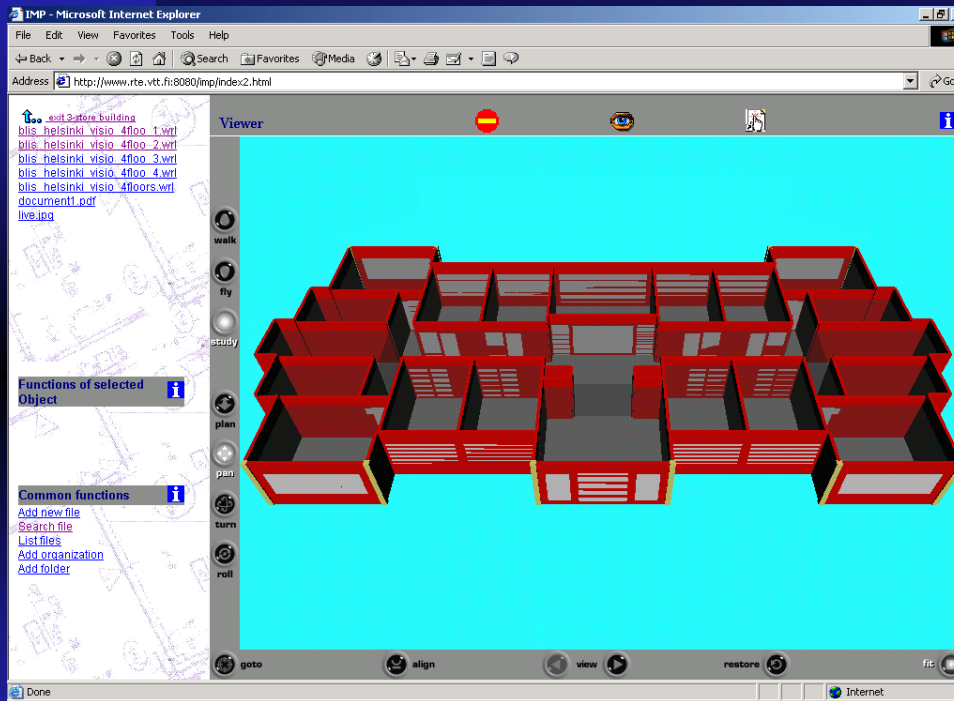
Web Service Method on IFC Model Server

Response from Server

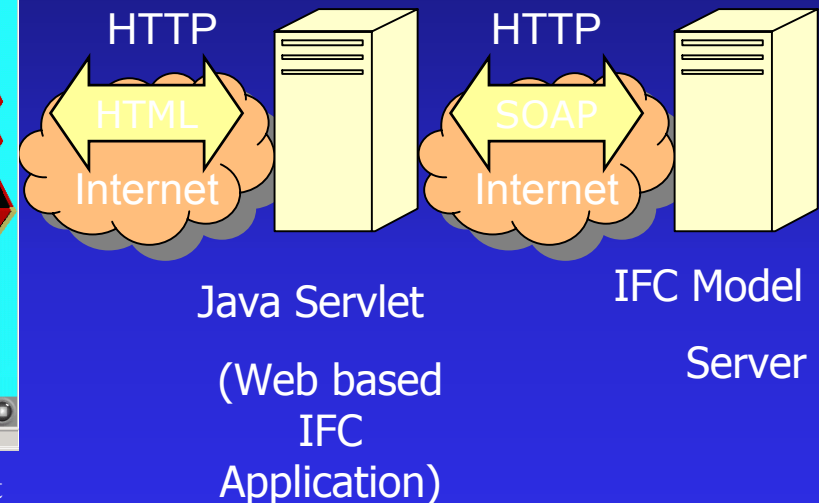
```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
- <SOAP-ENV:Envelope SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/" xmlns:SOAP-
  ENV="http://schemas.xmlsoap.org/soap/envelope/">
- <SOAP-ENV:Body>
  - <SOAPSDK1:GetObjectResponse xmlns:SOAPSDK1="http://tempuri.org/message/">
    - <Result>
      <IfcBuildingStorey GlobalId="bMt%>|bZR:ESVe%K@e2"
        OwnerHistory="B2A44FD17EE64CD0874DF0DEEDF4EA26"
        LocalPlacement="430E79F9E88144DDB9F8CA8CE7C91D46" BuildingStoreyReference="ACID1"
        BuildingStoreyName="" Elevation="0" calcTotalHeight="0" calcTotalArea="0" calcTotalVolume="0" />
    </Result>
  </SOAPSDK1:GetObjectResponse>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

IFC Object data (Enhanced BLIS-XML format)

Client Example: Java Servlet implementation (Apache-SOAP)



Developed by VTT Building and Transport



- Selecting building element on VRML Interface
- Getting selected element's properties from IFC model Server.

IMSvr Info

- <http://cic.vtt.fi/projects/ifcsvr/>
- In public domain
- Can be used now
 - ◆ Not a commercial product – support depend on original developers
- Next – SABLE project

Conclusions

- IFC is ready for pilot and real projects
- FAN should be BIM interoperable
- Examples of IFC Model Server Operation have been successfully demonstrated
- IFC models server are available for prototype FAN
- Recommend FAN to participate in SABLE FM view definition